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ANALYSIS OF NEARSHORE BATHYMETRY AND OPTICAL DATA FROM TUPS

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During June 1988, an experiment using NORDA's towed underwater pumping system (TUPS) was conducted in shallow water off Panama City, Florida to gather data in support of the Navy's Airborne Bathymetric Survey System (ABS). Continuous measurements were made of upwelling irradiance, fluorescence, transmissometry, water depth, temperature, and salinity using sensors in TUPS. Ambient light measurements and navigation data were recorded from instruments aboard the research vessel. This report describes the experiment, the cruise itinerary, and the methods used to carry out the measurements. Data are presented in graphical form, along with a description of the data reduction protocols and some preliminary results. Listings of computer programs used for processing the data are included. A description is given of the contents of a magnetic tape (provided to NORDA) containing all programs, raw and processed data.

Preliminary analysis of the data indicate that the quality of the light sensor and depth data are good. A significant inverse relationship between depth and upwelled irradiance was observed under some conditions. The relationship holds well in areas of bright sand, but is more complicated in areas of variable bottom type and water clarity. The broad suits of light and water quality sensors aboard TUPS make it an ideal system for providing the data to resolve such problems.

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Final Report

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GERG TECHNICAL REPORT 88-174

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

1.1 Rationale for the Study

The Naval Ocean Research and Development Activity (NORDA) has been developing and testing an Airborne Bathymetric Survey System (ABS) to measure water depth in coastal areas. The ABS is being developed by NORDA for the Defense Mapping Agency (DMA) and the Oceanographer of the Navy (CNO OP-096) under the NORDA Coastal Hydrographic Techniques Program. The ABS uses a laser system in conjunction with a multispectral scanner which measures upwelled irradiance at several wavelengths. The laser depth measurements and the multispectral scanner data are merged together to provide an algorithm which allows computation of depth from the multi-spectral scanner data alone.

The goal of the work reported here was to gather environmental data for making ground-truth measurement of the ABS. In addition to the ground truth support, this work was undertaken to help improve the present algorithms used by the ABS, by gaining a better understanding of the ocean's optical-environmental parameters. To accomplish these goals, NORDA equipped its towed underwater pumping system (TUPS) with a depth sensor (0-100 meter capable with 2 cm resolution) and upwelling irradiance sensors with fixed wavelength filters of 465 nm, 507 nm and 532 nm. This equipment was installed in TUPS during the spring of 1988.

It was decided to perform a field experiment using TUPS to provide ground-truth coverage for ABS overflights to be conducted during June 1988 off Panama City, Florida in the Gulf of Mexico.

For this experiment, the Geochemical and Environmental Research Group (GERG) of the Department of Oceanography at Texas A&M University was contracted (ONR Contract No. N00014-88-K-6003) to provide the ship and personnel required to tow the NORDA TUPS off Panama City, Florida. This effort included chartering a suitable vessel, installing the TUPS hardware and computers aboard the vessel, operating the system at sea during the cruise, collecting the TUPS data along with navigation and appropriate atmospheric information while at sea, and processing the data upon return to the laboratory.

This report describes the cruise data collected with TUPS off Panama City, Florida, on June 19, 20, 21, 1988. The data analysis procedures are described in detail and copies of FORTRAN computer programs use to process the data from collection to presentation are provided. A complete set of all data and programs is available on a VAX-compatible 9-track magnetic tape which was supplied to the NORDA Scientific Officer, Mr. Robert A. Arnone, along with this report. The complete data will be processed further by NORDA scientists to better understand the relationships between light, water clarity and depth in coastal regions.

1.2 Reasons for Using TUPS

To provide the ground-truth data for the Airborne Bathymetric Survey System (ABS), NORDA chose to use its towed underwater pumping system (TUPS). TUPS was designed and constructed at NORDA for a project to study "Chemical Dynamics in Ocean Frontal Areas". To meet the needs of that project and to provide the capability of performing other surface-water surveys, the TUPS tow vehicle was designed (Rein et al., 1985) to carry a large suite of oceanographic instruments. It was also designed to be easy to modify in order to allow other instruments to be quickly installed and interfaced to its on-board computer. The instrument layout of TUPS, as originally configured, is shown in Figure 1. The tow vehicle configured in this manner had been used successfully to study variability in water optical properties and environmental parameters in the western Mediterranean Sea (Arnone and Wiesenburg, 1988). Its successful use in previous studies and its easy adaptability made it an ideal instrument for studying the optical-depth relationships in coastal waters.

2.0 DATA COLLECTION

2.1 Study Area

The area chosen by NORDA for this study was the coastal area south of Panama City, Florida. This site was chosen because it was an region where different bottom types were available in close proximity to each other, thus minimizing

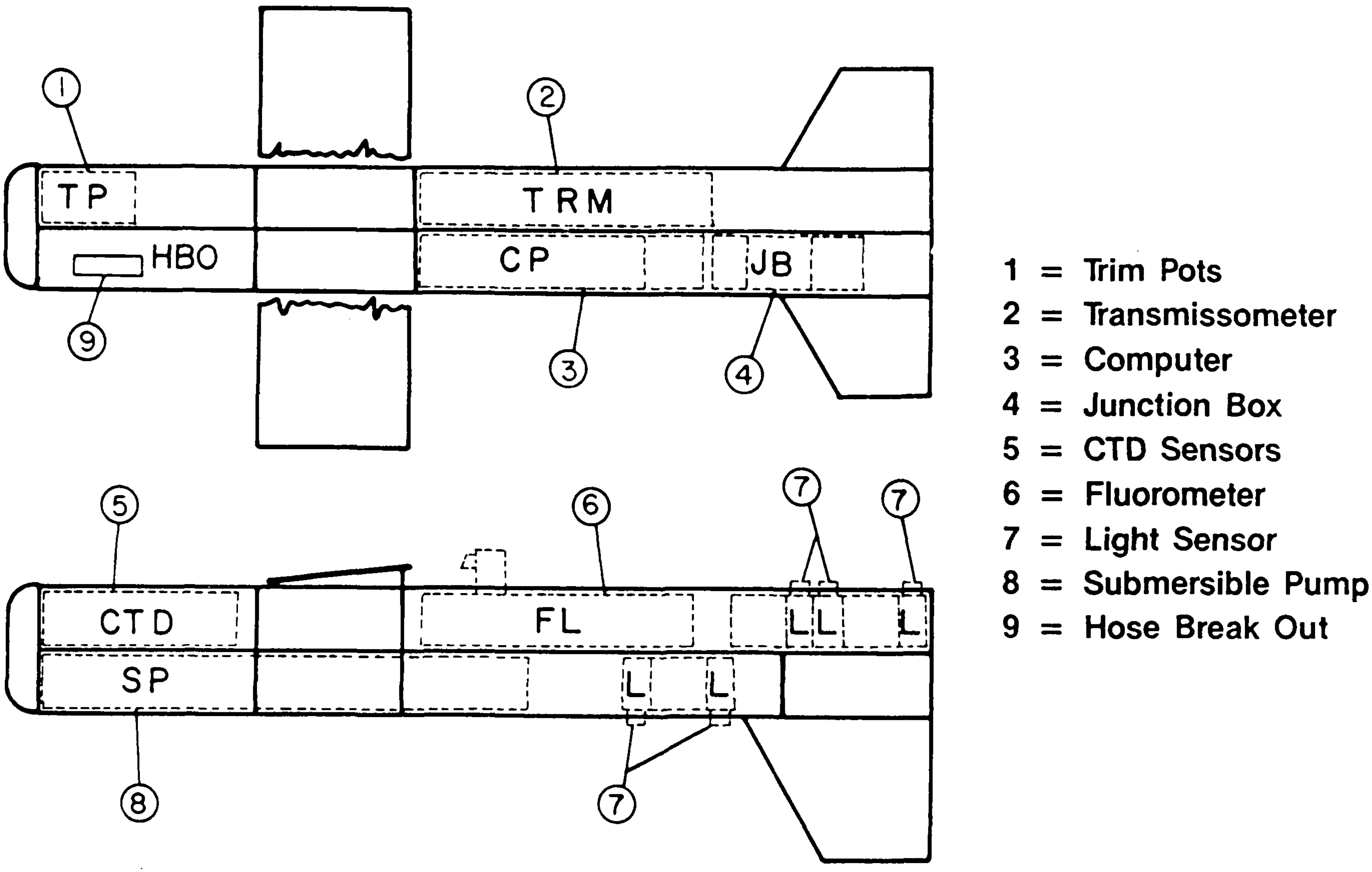


Figure 1. TUPS instrumentation layout as originally configured by NORDA.

the ship travel time required to study several different areas. The Panama City site was also selected for its close proximity to NORDA and the ability of the ABS-equipped P-3 aircraft to operate effectively out of nearby Eglin Air Force Base.

The study area is shown in Figure 2. This map is a 55% reduction (original scale 1:25,000) of a section of NOAA National Ocean Survey Chart No. 11391 (DMA Stock No. 11BHA11391). The map encompasses the area where the TUPS was towed during this experiment. On June 19 and 20, 1988, TUPS was towed in the Gulf of Mexico south of Shell Island. On June 21, 1988 TUPS was towed in the shallow area north of Shell Island.

2.2 Cruise Itinerary

The cruises undertaken during this experiment were conducted aboard the vessel Captain Graydon York, a forty-five (45) foot crew boat. The vessel was loaded with the TUPS and TESS equipment while docked at Sun Harbor Marina on June 18, 1988. TUPS was configured to be towed from the port side of the vessel using a davit that had been constructed at Texas A&M University especially for this experiment.

The Captain Graydon York departed Sun Harbor Marina at 1436Z (0936 CDT) on June 19, 1988 and proceeded to a known reference position (30°02.72'N, 85.41.60'W) to calibrate the TESS LORAN-C system. The LORAN was correct to 0.01' of latitude and longitude. The vessel then proceeded out the

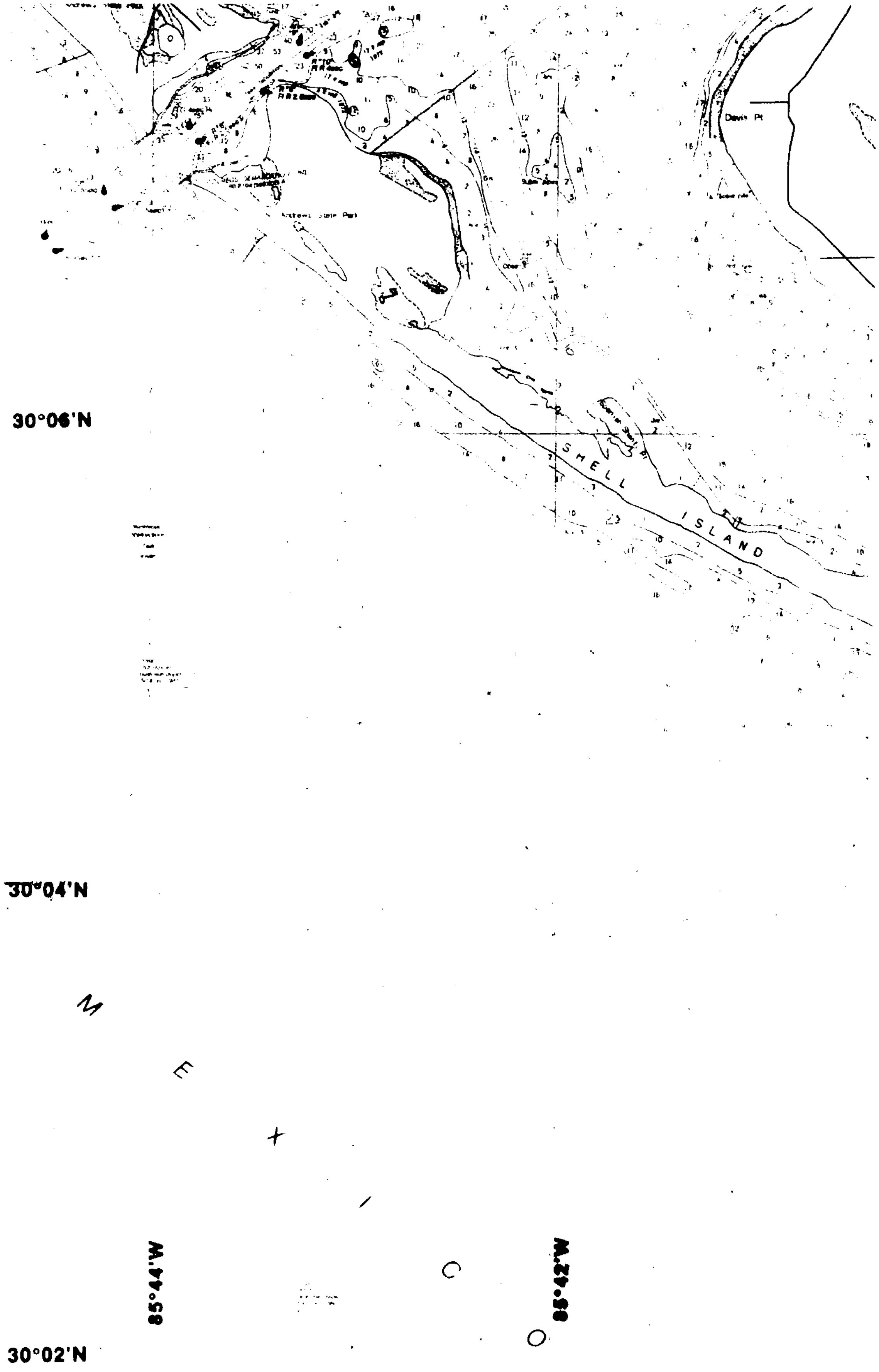


Figure 2. Chart of the study area south of Panama City, FL.

channel and south of Shell Island. TUPS was launched at 1600Z and after proceeding seaward was towed along lines perpendicular to the beach to provide a complete survey of the area. As the vessel approached the beach, we endeavored to go into as shallow water as possible. On two occasions (1847Z and 1854Z) the bow of the boat hit the bottom and severe course adjustments had to be made.

The TUPS survey south of Shell Island was completed at 2016Z. The TUPS tow vehicle remained in the water and collected data while anchor Stations 1 (2017Z-2102Z, 30°05.06N, 85°40.74W) and anchor Station 2 (2114Z-2202Z, 30°04.56N, 85°41.05W) were occupied. The TUPS tow vehicle was hoisted back aboard the vessel at the termination of anchor Station 2 and the vessel returned to port at 2252Z.

On June 20, 1988, the Captain Graydon York departed its dock at 1246Z and again performed a LORAN-C check at 1305Z. LORAN positions were exact with the reference position. The early portions of this day were devoted to a vertical station with the NORDA scanning radiometer system. Station 3 was occupied south of Shell Island at 30°02.15N, 85°45.95W from 1349Z to 1440Z.

After leaving this station, the vessel proceeded shoreward to launch TUPS in shallow water. TUPS was launched at 1504Z (1004 CDT) and a zig-zag pattern was run toward Shell Island with turns at 1542Z, 1552Z, 1558Z, 1605Z, 1611Z, and 1615Z. During the turn at 1615Z, the power generator aboard the Captain Graydon York stopped abruptly. The

generator had overheated due to a failure of the water pump on its cooling system. TUPS was retrieved at 1645Z and the vessel returned to its dock to affect repair of the faulty water pump. No further data were collected on June 20, 1988. Also, the data that had been collected were unreachable at that point as neither the TUPS or TESS data files had been closed properly when power was lost to the computer. The generator was repaired during the evening of June 20, 1988.

On June 21, 1988, the vessel left port at 1105Z (0605 CDT) proceeded to the LORAN reference point and then to a point on the leeward side of Shell Island (30°05.96N, 85°41.31W) where TUPS was launched at 1155Z. TUPS was towed until 1430Z when the vessel anchored for Station 4 at 30°06.27N, 85°41.72W. Station 4 was occupied from 1430Z to 1507Z. Station 5 (30°06.06N, 85°41.48W) was occupied from 1518Z to 1552Z and Station 6 (30°05.85N, 85°41.36W) was occupied from 1602Z to 1623Z. At this station, the TUPS tow vehicle was lowered from its normal tow depth beginning at 1602Z down to near the bottom and then returned to its normal two depth at 1613Z. Data at Station 6 were collected with TUPS until 1621Z.

The Captain Graydon York then proceeded to Station 7 (30°05.97N, 85°41.08'W) which it occupied from 1630Z to 1762Z. At this station, another vertical cast was made with TUPS. The descent started from the surface at 1643Z and terminated 1.17 m above the bottom at 1651Z. The TUPS tow body was retrieved slowly and arrived back at its normal 1.0

meter tow depth at 1722Z. After the end of Station 7, the vessel proceeded to Station 8 at 30°05.57'N, 85°40.61'W which it occupied from 1740Z to 1812Z. At the end of this station TUPS was retrieved and placed in its cradle in order to proceed rapidly to a point outside the jetties where it would be launched for a final survey through the Panama City channel.

TUPS was launched again at 1841Z at 30°06.79'N, 85°44.13'W and the vessel proceeded on a course of 320°T at 5.0 knots. This run across the channel was conducted from 1841Z to 1845Z. The transect was run about halfway between channel markers 1-2 and 3-4. After the channel crossing the vessel headed south then into the channel (at 1850Z) south of channel markers 1-2. The TUPS was then towed up the Panama City channel to the LORAN-C reference point (30°08.72'N, 85°41.60'W) where TUPS was retrieved at 1926Z. The Captain Graydon York then returned to its dock, arriving at 1943Z (1443 CDT). The NORDA equipment was off-loaded at that time ending the Panama City field experiment.

2.3 TUPS Sensor Configuration

During the Panama City experiment, the towed underwater pumping system (TUPS) was configured slightly differently than shown in Figure 1. The original configuration included pitch and roll sensors (Trim Pots), had only the capability for two upwelling light sensors and had no depth measuring capability. For this experiment, the trim pots were removed

to provide two extra data channels. One was used for a light sensor and the other was used for an echo sounder.

A list of sensors used on the TUPS during this experiment is shown in Table 1. Three upwelling light sensors at fixed wavelengths (465 nm, 507 nm and 532 nm) were mounted in the lower quadrant of the tow vehicle along with an Ulvertech, Ltd. Model 205 Echo Sounder (Depth Sensor). The echo sounder produced 500 kHz pulses with a power of 150 watts and beam width of four degrees. The unit produces an output voltage of 0-10 VDC which is proportional to 0-100 meters. It has a resolution of 2 cm.

Although the Ulvertech echo sounder was not provided with calibration data, calibrations were made by actual depth measurements (using divers) at several stations during the cruises. The echo sounder reported within 1 cm of the measured depth at 3.1 meters and within 10 cm of the reported depth at 4.4 meters.

2.4 TESS Sensor Configuration

To collect incident light measurements for comparison with the TUPS data, we used NORDA's TUPS Environmental Sensor System (TESS). This system (not to be confused with the Tactical Environmental Satellite System) was used to record total irradiance using two Eppley pyroheliometers as sensors. These measurements are important since clouds passing overhead reduce the amount of light hitting the ocean surface and consequently reduce the amount of upwelling irradiance.

Table 1. TUPS Sensor Configuration, June 1988

Channel*	Sensor	S/N	Calibration+
F0	Temperature sensor, Sea Bird, Inc.	SBE3-638	9-18-87
F1	Conductivity sensor, Sea Bird, Inc.	SBE4-234	9-18-87
A0	465 nm Upwelling Light, Biospherical Instr.	MCP-200H-7129	5-2-88
A1	507 nm Upwelling Light, Biospherical Instr.	MCP-200H-7130	5-2-88
A2	532 nm Upwelling Light, Biospherical Instr.	MCP-200H-7131	5-2-88
A3	Transmissiometer, Sea Tech, Inc.	165	12-31-86
A4	Fluorometer, Sea Mar Tech, Inc. (signal)	6000AR-235	None
A5	Fluorometer, Sea Mar Tech, Inc. (scale)	6000AR-235	None
A6	488 nm Downwelling Light, Biospherical Instr.	QCP-200LM-7101	2-22-86
A7	Echo Sounder, Ulvertech, LTD.	205	unknown

* TUPS on-board computer channel
\+ Date of last calibration if known

TESS also contained two narrow-band irradiance sensors with fixed wavelengths of 441 and 488 nm. Table 2 lists the sensors used during the Panama City experiment.

Table 2. TESS Sensor Configuration, June 1988

Channel	Sensor
4	Voltage Reference, 2.5V, Analog Devices AD580M
5	Pyroheliometer 1, light bulb, Eppley Instruments, Model 50, S/N 3039
8	Pyroheliometer 2, hemisphere, Eppley Instruments, Model PSP, S/N 8022D1
11	488 nm Light (linear), Biospherical Instruments, Model QCP-200HM-488, S/N 7105
12	441 nm Light (log), Biospherical Instrument, Model QCP-200LM-441, S/N 7102

2.5 TUPS At-Sea Data Collection

All sensors from the TUPS tow vehicle output their signals to an onboard computer. The Sea Bird temperature and conductivity sensors produce a frequency output and all other sensors have analog (voltage) outputs. These signals are converted by the TUPS computer to a hexadecimal code which is sent in ASCII format to the computer aboard the vessel. The shipboard computer used to integrate and collect data from the TUPS computer was a Digital Equipment Corporation Professional 350 (DEC PRO-350) running under the P/OS operating system. The DEC PRO-350 collected a line of data

from the TUPS computer every 5-6 seconds, added a date and time to the data line and wrote the data line to the computer's hard disk. This operation was controlled by a BASIC program (SLOGTUPS) which collects the data, calculates and displays the results in engineering units and writes the raw data to disk.

2.6 TESS At-Sea Data Collection

The data collected from the TUPS environmental sensor system (TESS) include navigation information as well as light data. TESS data are collected with a Zenith Data Systems Model 121 (Z-121) computer running MS/DOS version 2.17. The navigation information is transmitted to the Z-121 computer via an RS-232 interface. The navigation data is collected from an INTERNAV LC-300 LORAN-C which outputs position, time delays and calculated speed and heading every 12 seconds. The LORAN output is used as a trigger for the Z-121 BASIC data logging program (LOGTESS). When the navigation data is sent to the Z-121, the computer records the day and time and samples the A/D board that is receiving data from the TESS light sensors. Each light sensor is read five times and an average is determined. The time and position information along with the average light voltages are displayed on the Z-121 screen and simultaneously written to the floppy disk in ASCII format.

2.7 Data Collection Problems

Relatively few problems occurred during collection of the data. The LORAN-C positions off Panama City, Florida, are very good due to the near-perpendicular crossings of the time delay lines. Most of the TUPS sensors were well-calibrated and produced acceptable data with a few exceptions (e.g. the fluorometer) that could be connected by judicious filtering of the data.

The one major problem did not involve the TUPS or TESS equipment, but rather the loss of ship's power at 1615Z on June 20, 1988. This event is described in section 2.2. The loss of power caused the computer disk files on the DEC-350 (hard disk) and the Z-121 (floppy disk) not to be closed properly. Although the data had been written to the disks immediately after it was collected, it could not be read in the normal fashion because location blocks for the file had not been written to the disk. These data were later recovered using a technique that is described in section 3.3.

3.0 DATA ANALYSIS

3.1 Inspection of Data Collected

Immediately after the Panama City experiment, the TUPS and TESS data files were transferred from the disk on which they were recorded (DEC 350 or Z-121) to the GERG VAX for processing. The files were scanned to make sure each data line was complete and that each file had ended with a complete line of data. Incomplete data lines were either

removed or edited if the error was obvious. Most of the data files were in excellent condition. It was obvious however, that there was a problem with spiking in the fluorometer data that would need attending to.

3.2 Problems with Collected Data

After the initial inspection, the TUPS and TESS files were converted to engineering units. The programs used are described in section 3.5. A quick look at the raw data indicated that there were significant problems with the data from downwelling light sensor in TUPS and the 488 nm TESS (atmospheric) sensor. The downwelling light sensor (looking up) in TUPS was supposed to be a Biospherical Instruments 400-700 nm broadband sensor that measures photosynthetically-active radiation (PAR). Inadvertently, a narrow band 488 nm sensor (Biospherical Instruments, Inc. Model QCP-200LM-7101) was installed in its place. This sensor was intended for the TESS system. The 488 nm sensor in TUPS was a logarithmic sensor intended to operate in air. The calibration for this unit is an air calibration thus the values reported for this sensor are questionable.

An incorrect sensor was also installed in the TESS. Instead of installing the logarithmic 448 nm sensor in TESS, a high gain 488 nm sensor (Biospherical Instruments, Inc. Model QCP-200HM-488-7105) had been installed previously during the Spring of 1988. The calibration for this unit was for use in water only, thus the data from this sensor is also

questionable. In fact, examination of the time series plots indicates that the sensor was saturated almost all the time during this three day experiment.

A more significant problem was the fluorometer data. About half of the data points were unusable. The SeaMarTech fluorometer can produce a noisy signal due to the capacitor discharge when its strobe light is flashing. If the TUPS computer samples at this time, an errant data point will be recorded. We have recommended that NORDA add an electronic filter to their fluorometer to correct this problem in the future. There is also a problem with the fluorometer when it is changing scales. The fluorometer may jump between scales rapidly before it settles on one scale. When the TUPS computer samples during this period of scale change an errant data point is recorded. Since the Sea Mar Tech fluorometer does not change scale very smoothly this process also added to the bad fluorometer data recorded.

There were only a few problems with the other TUPS sensors. When the vessel ran aground, much sediment was stirred-up into the water column. Sensors that work by having water pass through them (conductivity and transmission) are affected by this extra suspended sediment. Both these sensors had spikes in the data lines when the ship ran aground. These spikes were filtered from the data.

3.3 Recovery of Lost data

On 20 June 1988 the generator overheated on the Captain Graydon York causing the unit to shut down. The resultant power failure caused TUPS data files, written on the DEC PRO-350 hard disk, not to be closed. Although the data were written on the disk, the directory entry for the data files was not complete and the files could not be read in the usual fashion. Features for the recovery of the data were not available in the P/OS operating system of the DEC PRO-350 computer. We undertook the job of recovering these lost files so the TUPS data from June 20, 1988 could be saved.

Our strategy for recovering those files was as follows:

a. Boot an RT-11 system from a floppy disk on the PRO-350. RT-11 is another DEC operating system that can be used on the PRO-350. FORTRAN subroutines are available in the RT-11 system library that can bypass normal directory usage and allow individual blocks of data to be read anywhere on the hard disk.

b. On another DEC LSI-11 computer available at TAMU-GERG, develop a FORTRAN program that could be operated under RT-11 and could search the disk and recover blocks containing Panama City data. All of the lost TUPS data contained the string "20-JUN-88" so the program was instructed to copy all blocks that contained this string to a new file on a RT-11 floppy disk. The program, named READ350, is listed in Appendix A.

c. The program READ350 was run on the PRO-350 and all data recovered to a RT-11 floppy disk.

d. The data on the RT-11 floppy disk was transferred to the VAX using the DEC LSI-11 computer available at TAMU-GERG.

e. The data was edited to clean up a few bad characters. Essentially all lost data was recovered in this manner.

The TESS data collected on the Zenith 121 computer was recovered by Robert A. Arnone at NORDA using a "Brown Bag" data recovery program. This recovery process provided multiple ASCII files of the data which were slightly overlapping. The recovered data files were transferred to the GERG VAX merged into a single file and edited to remove all duplicate data records produced by the recovery program. This recovery of the TESS data from June 20, 1988 provided a clean TESS file for processing along with the files from the other two days.

3.4 Data Analysis Protocol

TESS data records contain time and voltages in ASCII. TUPS data records contain time and date in ASCII together with voltages and frequencies in a hexadecimal format. Some sensors are inherently noisy. TESS and TUPS data are not collected at exactly the same time. The goal of the data analysis protocol is to convert the raw TESS and TUPS data into a unified data set containing time series of all measured variables in engineering units with erroneous data and noise removed as much as possible.

Analysis proceeds in a number of steps with intermediate results stored as files. The process is shown schematically in Figure 3 and Figure 4. Square boxes indicate data sets and parallelograms represent computer programs.

First, the TESS data are read and converted into engineering units by program READJUN. Formulas used to convert voltages to engineering units are best found in the programs in Appendix A.

Second, TUPS data are converted to engineering units by program CONVERT88.

Third, certain noisy measurements (depth, fluorescence) are filtered using program PRETABLE. Rather than just applying a low pass filter, PRETABLE tries to make intelligent decisions about what data points are noise and removes them from the time series.

Fourth, TESS data are interpolated to the time of the TUPS data and interpolated TESS data and the TUPS data are merged using program MERGETT. This is done for each of the three days. The result is 3 files containing the desired smooth data sets of all data collected on each day of the Panama City experiment.

Fifth, a quick look data plotting program (TTPLOT) was written to read the merged data set and plot each time series on on large poster-sized plot.

Sixth, a SAS program (READ.SAS) was written to read all final data sets and consolidate them into one SAS data set. SAS data sets are self documenting and facilitate the use of

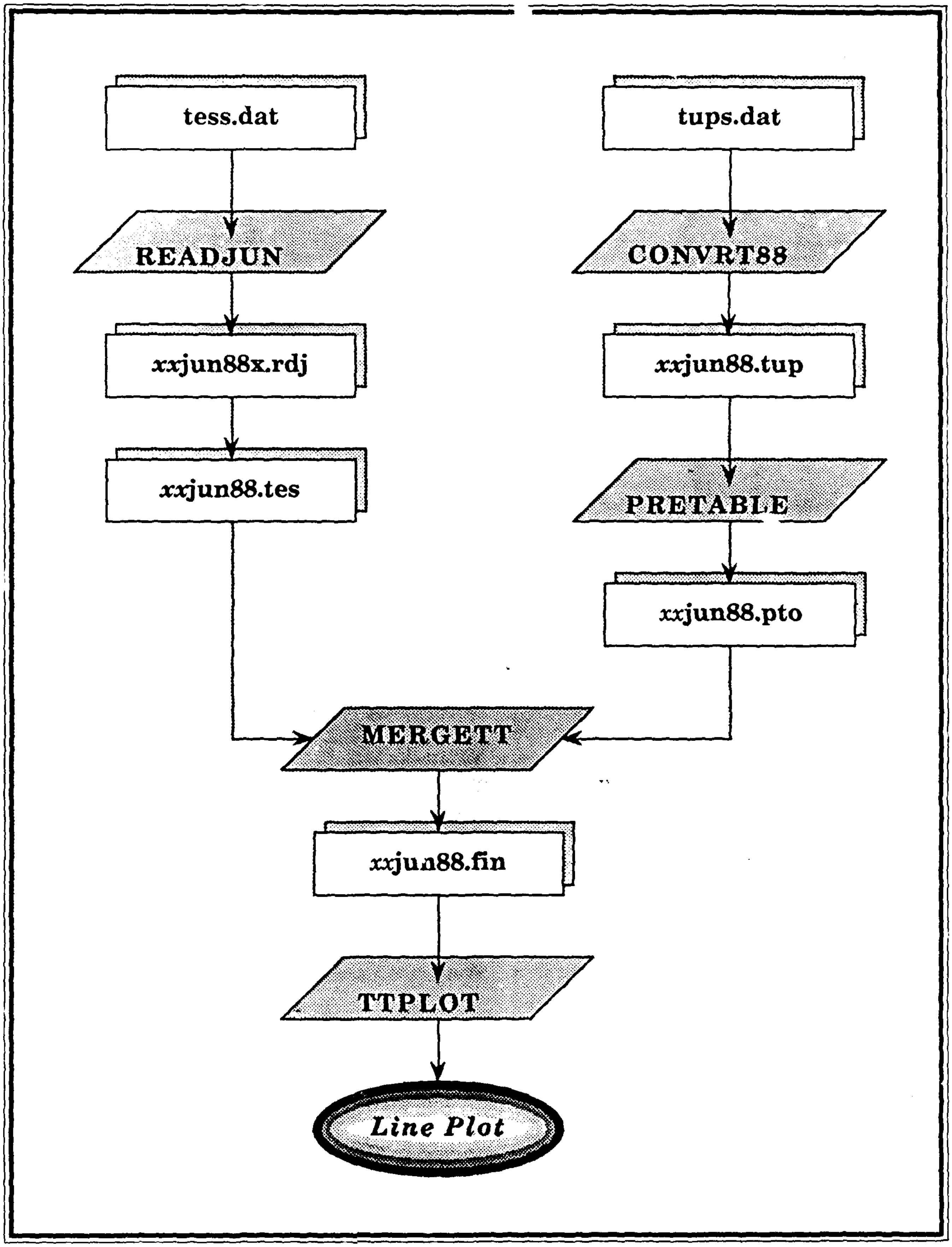


Figure 3. Flow diagram of data processing protocol showing FORTRAN programs used and data file names.

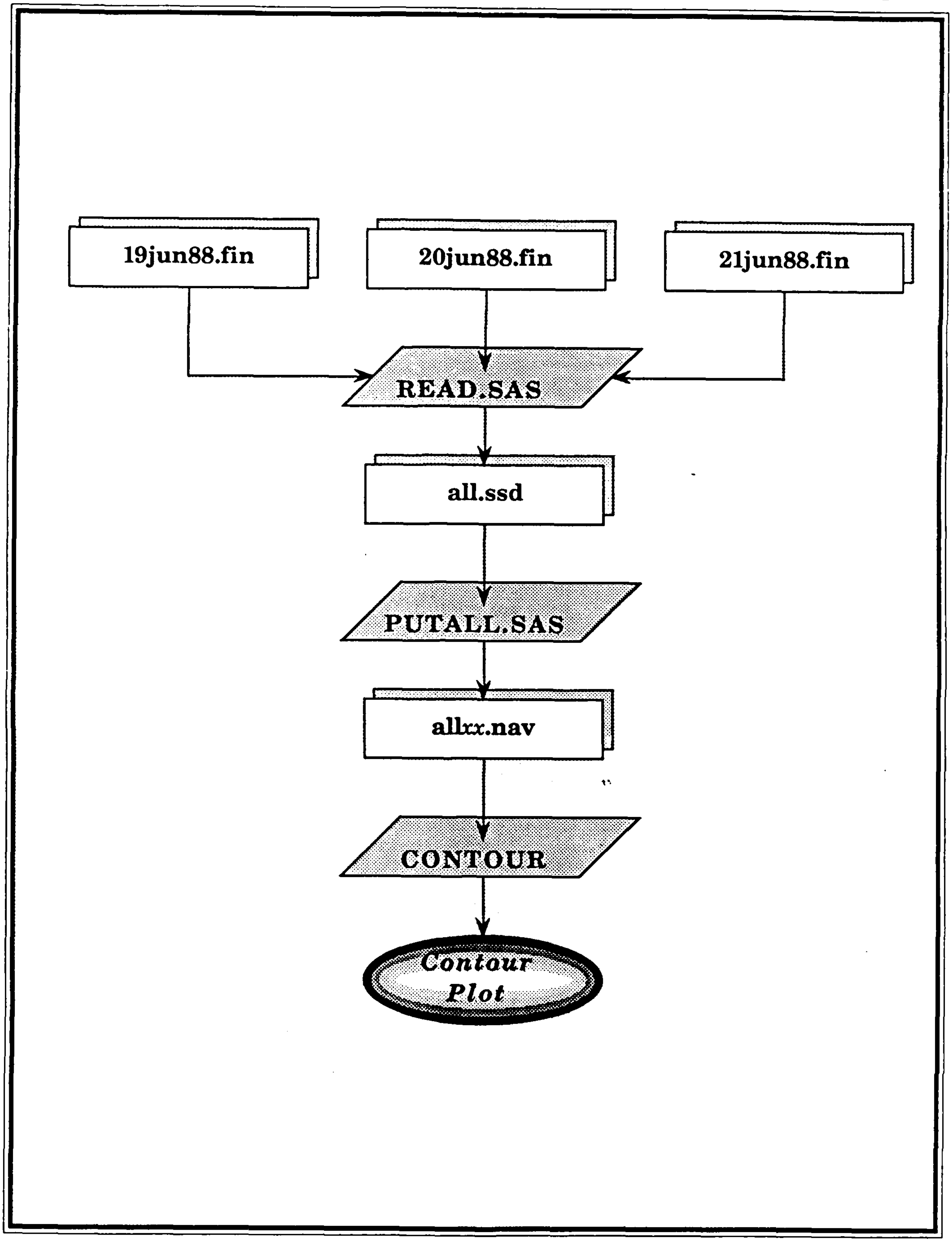


Figure 4. Flow diagram of data processing protocol showing SAS programs used and data file names.

powerful SAS statistical routines. Another SAS program was written to extract subsets of environmentally significant variables for further analysis.

Seventh, a contouring program (CONTOUR) was used to prepare contour plots for each of the three days for all environmentally significant variables.

The smooth data files that we recommend be used for further processing are the 19JUN88.FIN, 20JUN88.FIN and 21JUN88.FIN files produced by the MERGETT program. Table 3 gives a listing of the position in the record (array number) of each of the data items, the descriptive name of the data item, the SAS name used for the correlation analysis and the units of each data item as reported.

3.5 Description of Computer Programs

The following is a brief description of the programs that were used to analyze the data and to prepare the figures in this report. The listings of the programs are presented in Appendix A for information purposes only. The listing does not imply any transfer of ownership or guarantee that the program will operate on any data sets or computers other than those actually used in the course of this work. Some of these programs are based on previously-developed programs. They use subroutines of commercial or public domain origin available on the TAMU-GERG VAX.

Table 3. Position in data record (from XXJUN88.FIN files), descriptive name, SAS name and units for data presented in this report and on the data tape supplied to NORDA.

Position	Descriptive Name	SAS Name	Units
1	Year	-------	----------
2	Month	-------	----------
3	Day	-------	----------
4	Time	-------	HH:MM:SS(UT)
5	Seconds Past Midnight	-------	sec
6	Latitude	-------	deg
7	Longitude	-------	deg
8	Time Delay 1	-------	µsec
9	Time Delay 2	-------	µsec
10	Heading	-------	deg
11	Speed	-------	knots
12	Voltage Reference	-------	volts
13	441 nm light (TESS)	TESS441	$\mu W/cm^2 sec\ nm$
14	488 nm light (TESS)	TESS488	$\mu W/cm^2\ nm$
15	Pyroheliometer 1	TESSPYR1	$\mu W/cm^2 sec*10^{-4}$
16	Pyroheliometer 2	TESSPYR2	$\mu W/cm^2 sec*10^{-4}$
17	Temperature	TEMPER	°C
18	Salinity	SALIN	PSU
19	% Transmission	PTRANS	%
20	Fluorescence	FLUOR	rel. units
21	465 nm Upwelling Light	L465NM	$\mu W/CM^2/nm$
22	507 nm Upwelling Light	L507NM	$\mu W/CM^2/nm$
23	532 nm Upwelling Light	L532NM	$\mu W/CM^2/nm$
24	Transmissometer Voltage	------	Volts
25	Fluorometer Signal Voltage	------	Volts
26	Fluorometer Scale Voltage	------	Volts
27	488 nm Downselling Light	L488NM	$\mu W/cm^2 sec\ nm$
28	Depth	DEPTH	Meters

1. **CONVERT88** (convert raw TUPS files).

This program reads the raw hexadecimal data file produced by the TUPS as configured during June 1988 and converts data to engineering units. The output files produced by this program have the extension "CNV".

2. **READJUN** (read June {TESS} files).

This program reads the files produced by the TESS program (as configured during June 1988) and produces a clean data file in engineering units. The output files produced by this program have the extension "RDJ".

3. **PRETABLE** (preprocess TUPS file).

This program reads the TUPS files produced by CONVERT88 and filters the data. A special filter (which does not average-in fliers) is used for the fluorescence, depth, and some other data. The output files produced by this program have the extension "PTO".

4. **MERGETT** (merge TESS and TUPS data).

This program reads the output from READJUN (TESS) and PRETABLE (TUPS) and produces a uniform data set containing TESS and TUPS data. TESS data is interpolated to TUPS times. The output files produced by this program have the extension "FIN".

5. **TTPLOT** (TESS TUPS plot).

This program uses NCAR subroutines to plot all elements of the unified data set against time. A large format plot showing all data is output on 32 in by 42 in inch paper.

6. **CONTOUR** (contour 13 TESS-TUPS variables).

This program contours data along the cruise track. The cruise track is show as a dotted line. Land areas are also displayed. A masking algorithm is used to produce contours only within a certain distance of the cruise track. The same algorithm is used to mask out contours that might be drawn over land.

7. **M1** (map one).

This program is used to convert digitizer (x,y) data to latitude-longitude coordinates. A latitude-longitude grid is first digitized from 20 known positions to produce a calibration field. Then the data locations are digitized. The program does a third-order orthogonal polynomial fit to the calibration points and then uses the resultant coefficients to calculate latitude and longitude for the data locations. The program was used to provide the digitized island shown in the contour maps.

8. **READ.SAS** (read all final data sets)

This program reads final, merged data sets (date.fin) and converts all Panama City data into a SAS data set.

9. **PUTALL.SAS** (extract subset of environmental data for plotting to ASCII file)

This is a SAS program that can use simple statements to make an ASCII file to be used by the plotting programs.

10. **CORR.SAS** (make correlation matrix)

This program produces a correlation matrix of all the Panama City data.

11. **READ350** (read and recover PRO-350 data)

This is an RT-11 program that uses RT-11 system subroutine calls to read the hard disk on the PRO-350 and recover blocks of lost data. These data could not be read in the usual fashion because their directly entry was incomplete due to a power failure while the data were being written to the PRO-350 disk.

12. **PLOT.SAS** (make x vs. y plot)

This SAS program plots the inverse of NUR against depth. Inverse NUR (INORM_UP = TESSPYR1/L507NM) is plotted against depth for each day for all depths less than 12 meters

4.0 DATA PRESENTATION

4.1 Time Series Plots

Time series data for each day were plotted on 42" by 32" paper to facilitate examination of the data. Page size versions of these plots are shown in Figure 5, 6 and 7 for June 19, June 20, and June 21. Each time series is scaled such that it fills its own box. The minimum and maximum value for each box is indicated near the right hand edge. Time starts on even hours. For example, Figure 6 shows 1500Z tc 1700Z. It is apparent that the TUPS upwelling irradiance sensors (Panels 7, 8, and 9 from the top) clearly measure the increase in upwelling irradiance in shallow water. Also evident is the general inverse relationship between fluorescence and transmission.

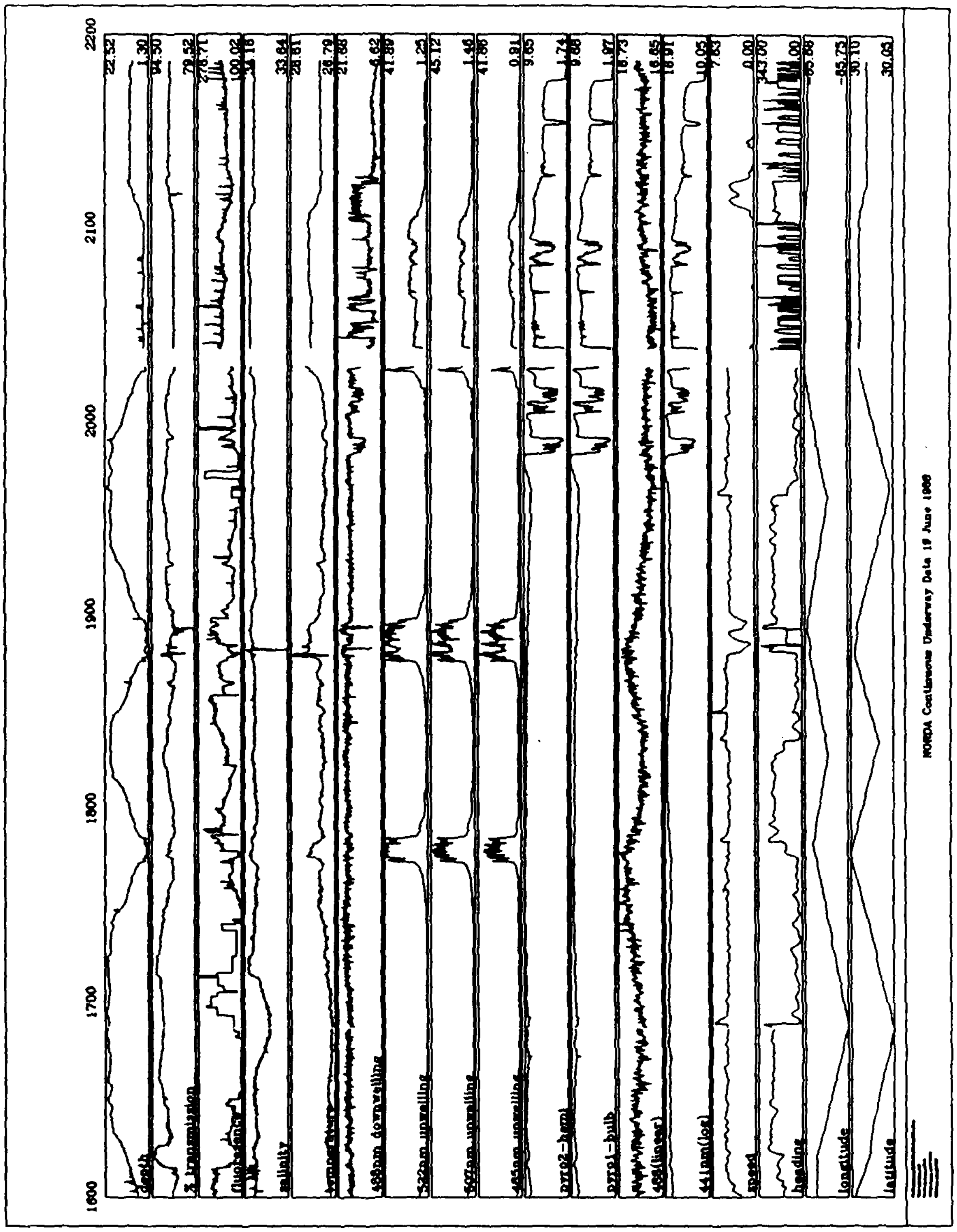


Figure 5. Time series plot of combined data from 19 June 1988.

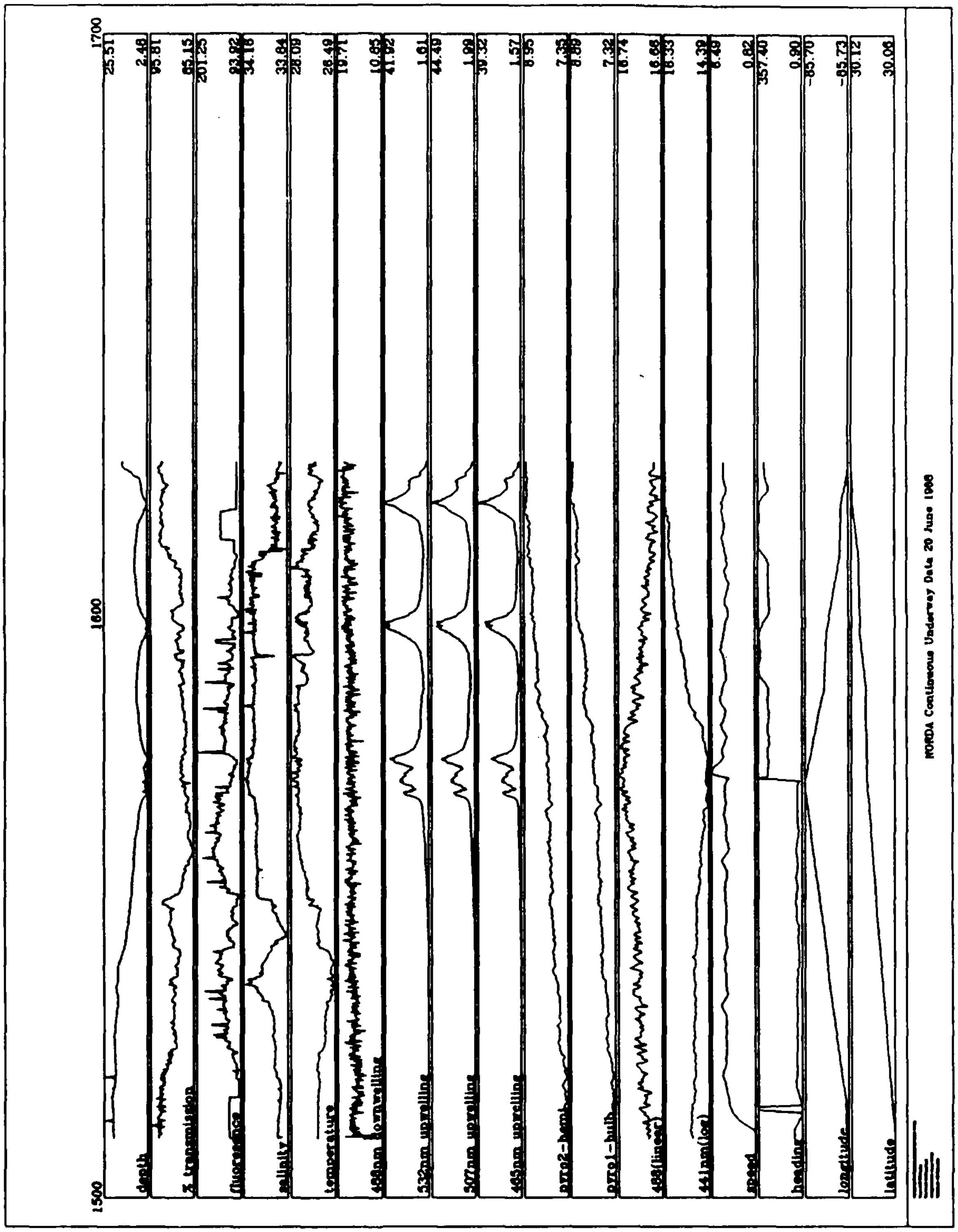


Figure 6. Time series plot of combined data from 20 June 1988.

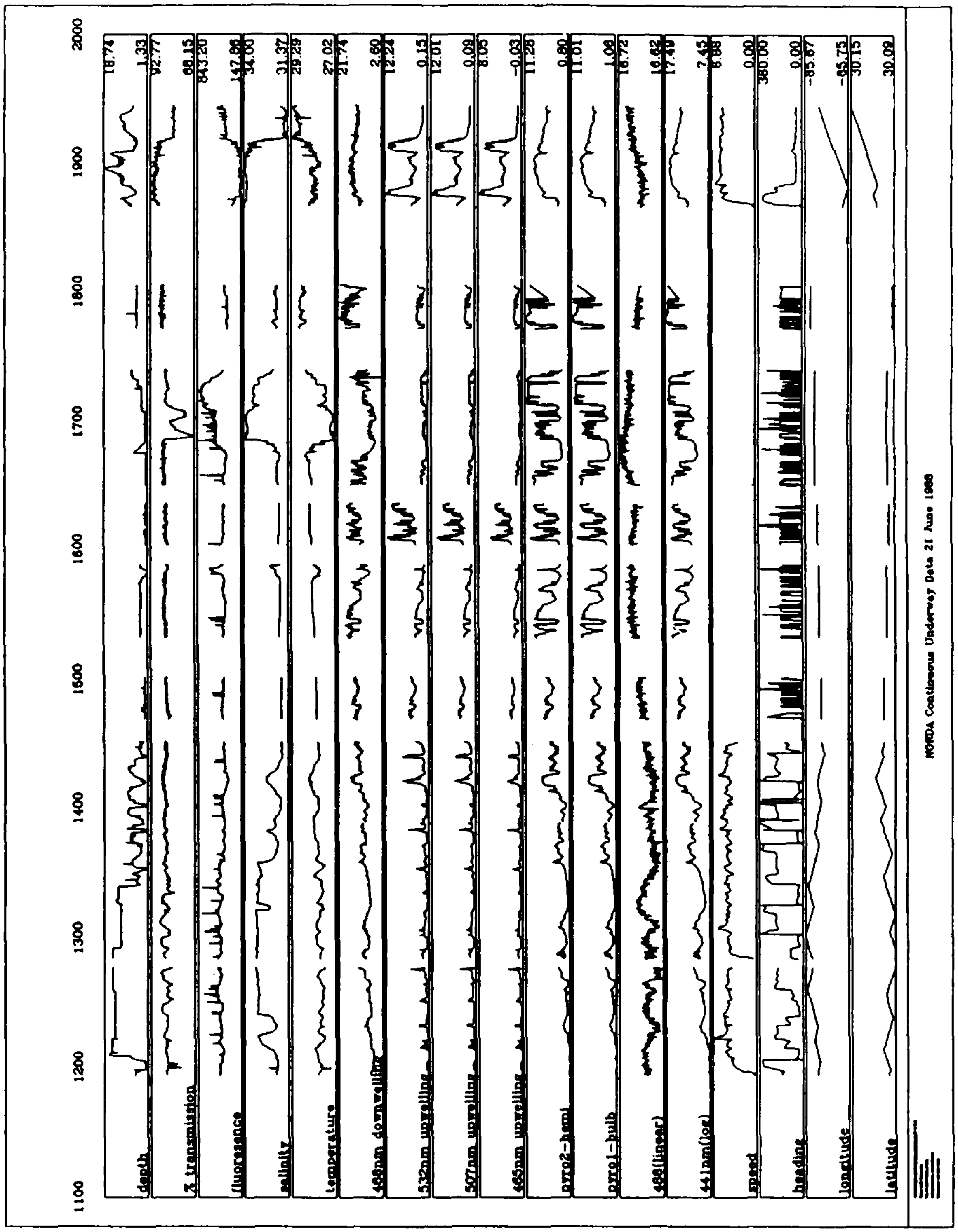


Figure 7. Time series plot of combined data from 21 June 1988.

4.2 Contour Maps for Each Day

Appendix B contains contour plots for 13 environmental variables for each day of the cruise. These are intended to give a quick look at the spatial quality of the data. Where cruise traces are relatively uniformly spaced and there are more than one track as on June 19, the data such as depth contour nicely. Passage of clouds show up dramatically as holes in the light field.

4.3 SAS Analysis of Total Data Set

As mentioned in sections 3.4 and 3.5, all data were placed in a SAS data file to facilitate statistical analysis. The Pearson correlation matrix was calculated for the entire data set (all 3 days) for the flowing variables:

- TESS light sensors: 441 nm, 448 nm, Pyrometer 1, Pyrometer 2
- TUPS sensors: Temperature, Salinity, Depth, Fluorescence, Percent Transmission
- TUPS light sensors: 465 nm, 488 nm, 507 nm, 532 nm.

This matrix is shown in Table 4. Correlation coefficients are highlighted when their absolute value exceeds 0.60 to draw attention to the most significant correlations.

Three of the four TESS light sensors are highly correlated with correlation coefficients exceeding 0.97. The 488 nm TESS sensor has a low correlation with the other three

Table 4. Pearson correlation matrix of TUPS and TESS measurements from the Panama City Experiment. Correlations with an absolute values over 0.600 are in bold.

VARIABLE	TESS448	TESS441	TESSPYR1	TESSPYR2	TEMPER	SALIN	PTRANS	FLUOR	L465NM	L507NM	L532NM	L488NM	DEPTH
TESS448	1.000												
TESS441	0.460	1.000											
TESSPYR1	0.517	**0.978**	1.000										
TESSPYR2	0.522	**0.978**	**0.997**	1.000									
TEMPER	-0.209	-0.331	-0.353	-0.355	1.000								
SALIN	0.281	0.480	0.499	0.499	**-0.744**	1.000							
PTRANS	0.163	0.514	0.504	0.504	-0.547	**0.623**	*1.000*						
FLUOR	-0.323	**-0.640**	**-0.621**	**-0.615**	0.528	**-0.725**	**-0.791**	1.000					
L465NM	0.262	0.364	0.379	0.380	-0.074	0.390	0.261	-0.414	1.000				
L507NM	0.259	0.352	0.367	0.366	-0.011	0.354	0.205	-0.380	**0.989**	1.000			
L532NM	0.249	0.320	0.336	0.336	0.033	0.310	0.155	-0.334	**0.975**	**0.995**	1.000		
L488NM	0.397	**0.805**	**0.809**	0.812	-0.340	0.399	**0.600**	**-0.673**	0.354	0.320	0.286	1.000	
DEPTH	-0.043	0.182	0.195	0.201	-0.596	0.456	0.561	-0.434	-0.235	-0.329	-0.374	0.350	1.000

TESS light sensors. This provides additional evidence that the TESS 488 nm sensor was not working properly.

Fluorescence is negatively correlated with transmission which implies that the principle light scatterers in the area are phytoplankton. Fluorescence is negatively correlated with the three light sensors which probably reflects the increasing efficiency of plankton fluorescence with decreasing ambient light. Fluorescence is negatively correlated with salinity which implies the fresher bay waters contain more chlorophyll.

Salinity and temperature are negatively correlated; the bay waters are warmer and fresher than the open ocean waters off the beach. Three TUPS light sensors measuring upwelling light are highly correlated.

We made a quick look assessment of the depth and light data to see how well water depth could be predicted by the intensity of upwelling irradiation. First we normalized the upwelling intensity to the downward radiation measured by the on board TESS sensors. Since the three TESS light measurements were highly intercorrelated and since the three TUPS measurements of upwelling irradiation were also highly correlated, we felt justified in choosing one of each for this normalization. We defined *normalized upwelling radiation*, NUR, to be the TUPS 507 nm sensor data divided by the TESS Pyroheliometer 1.

The inverse of NUR is plotted against depth in meters in Figure 8. This is a SAS plot where the letters indicate the

number of data items under each letter. An A represents one data item, a B represents two data items, and so forth. A Z indicates 26 or more data items. Figure 8 shows that for all the data collected on June 19, depth is roughly proportional to the inverse of NUR. Figure 9 show the same for the June 20 data. Again depth seems predictable by the inverse of the NUR.

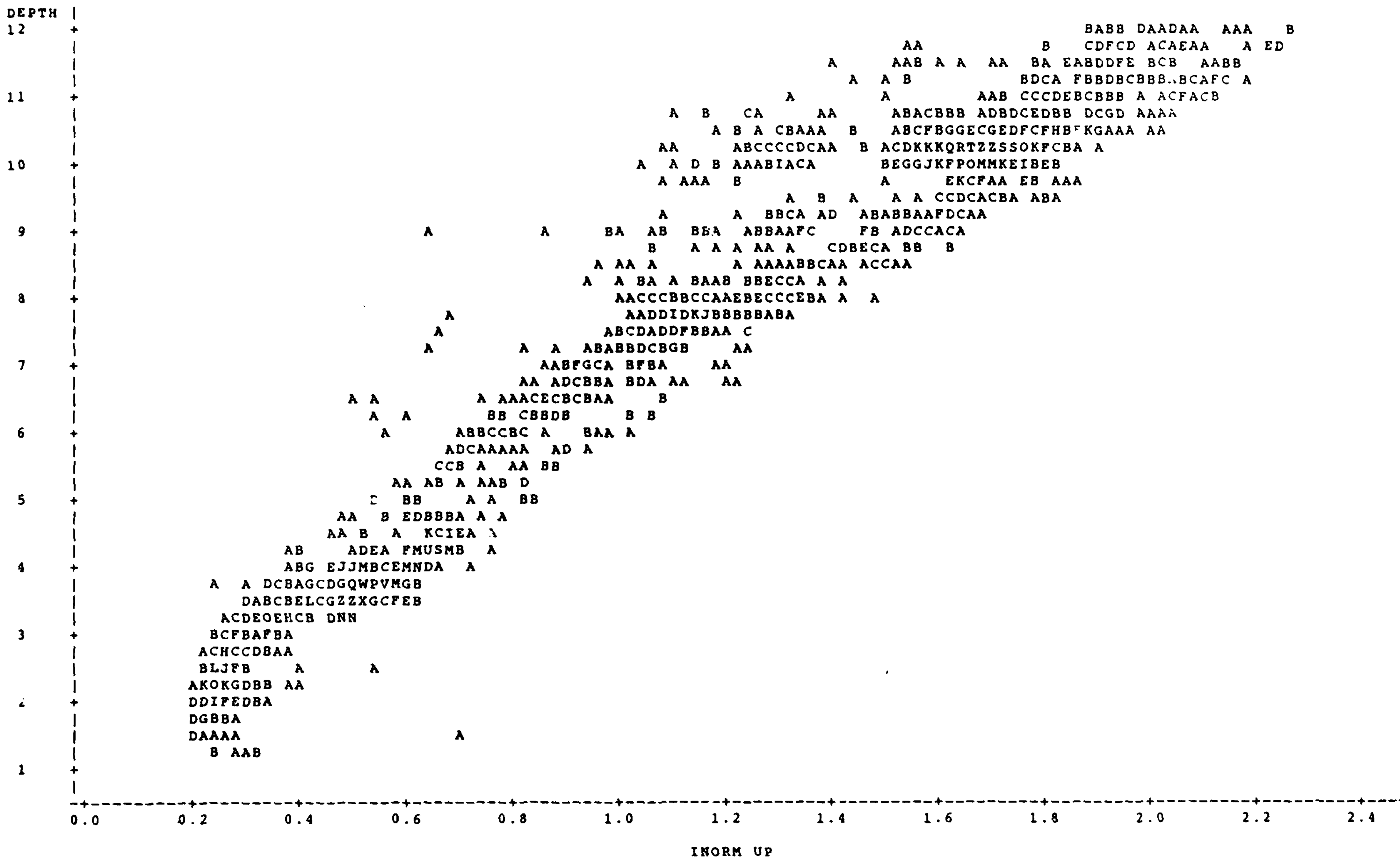
Figure 10 for June 21 show a very different picture for the data collected behind the barrier islands. No simple relationship exists between NUR and water depth. Bottom types encountered on June 21 included mud, bright sand and grass. Bottom types encountered on June 19 and 20 were mostly bright sand. Bottom reflectance may play a role in distorting the relationship between NUR and water depth. Other environmental variables such as turbidity and pigment concentrations most certainly also play a role. The data, of course, warrant further analysis.

4.4 Description of Deliverables

Provided to NORDA in addition to this report were three 42" x 32" versions of Figures 5, 6 and 7. Also provided was a nine track magnetic tape in VAX BACKUP format that contains all data files described in this report, plus copies of all FORTRAN and SAS programs. Data files generally are ASCII FORTRAN output files with a carriage return line feed pair (CR-LF) at the end of each line. The BACKUP log that contains

INVERSE NORMALIZED 507NM UPWELLING IRRADIANCE   10:51 THURSDAY, DECEMBER 22, 1988   1
19 JUNE 1988

PLOT OF DEPTH*INORM_UP   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 31 OBS HIDDEN

Figure 8. Plot of inverse of normalized upwelling irradiance versus depth on 19 June 1988.

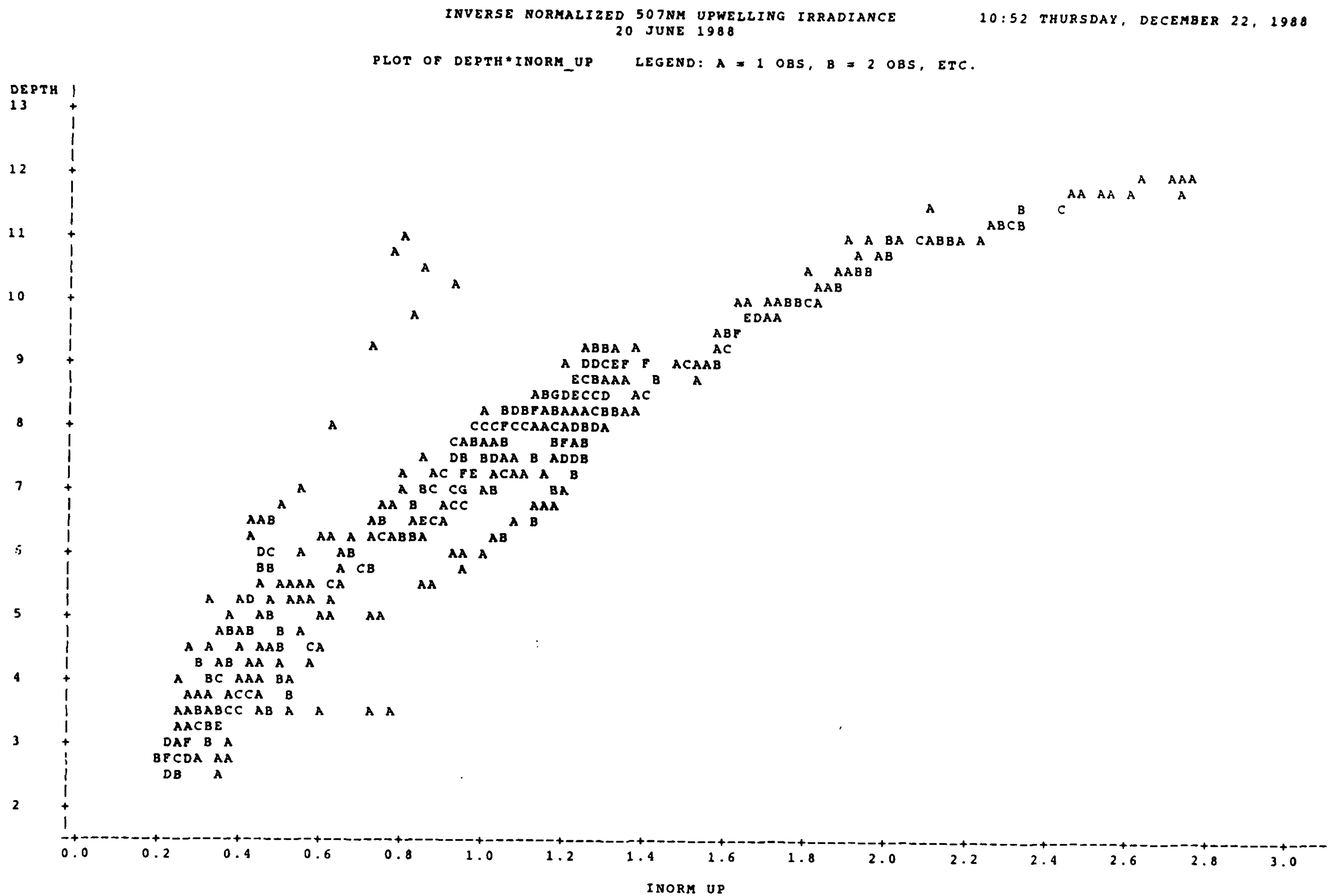
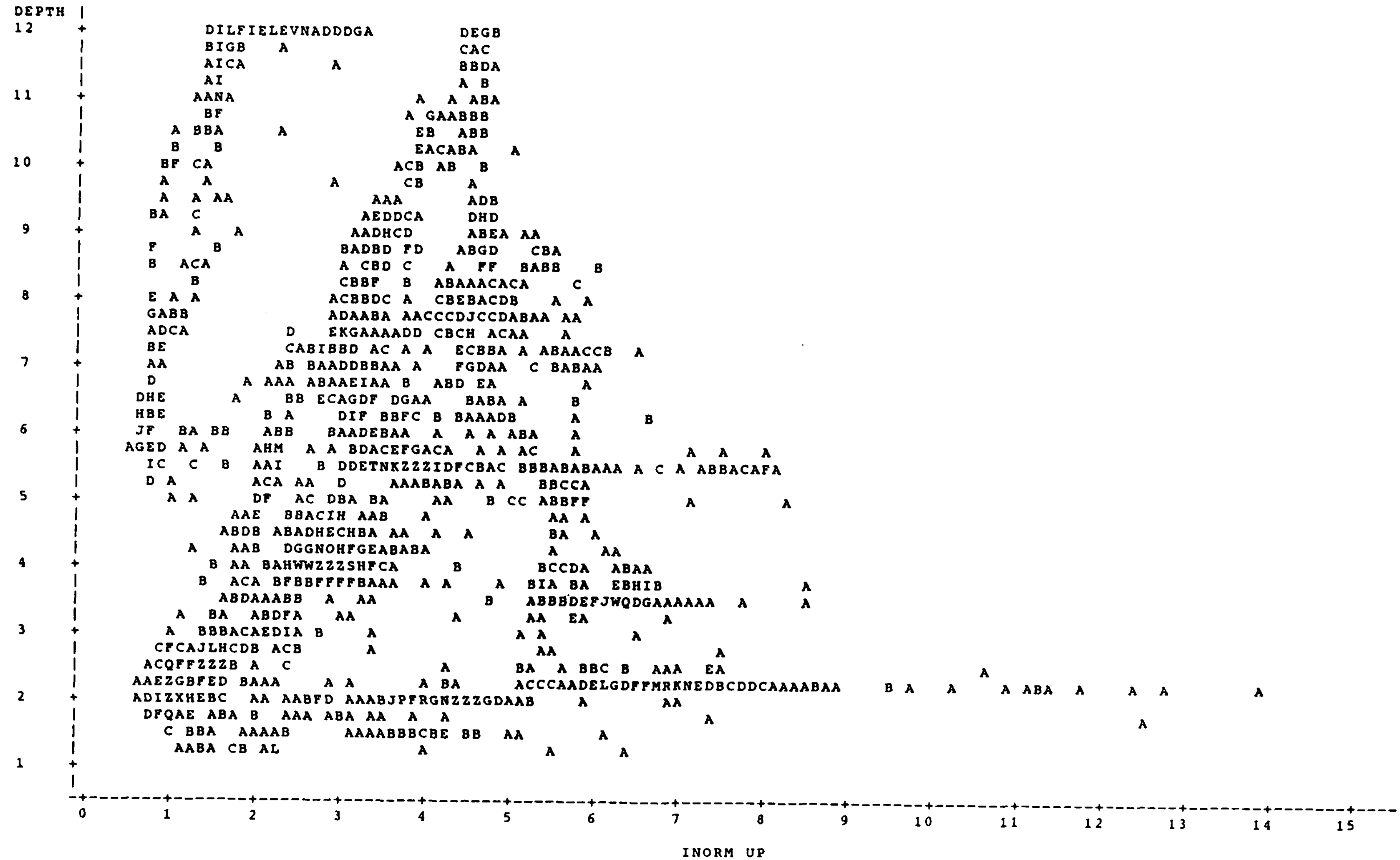


Figure 9. Plot of inverse of normalized upwelling irradiance versus depth on 20 June 1988.

INVERSE NORMALIZED 507NM UPWELLING IRRADIANCE 21 JUNE 1988 10:53 THURSDAY, DECEMBER 22, 1988 3

PLOT OF DEPTH*INORM_UP LEGEND: A = 1 OBS, B = 2 OBS, ETC.



NOTE: 410 OBS HIDDEN

Figure 10. Plot of inverse of normalized upwelling irradiance versus depth on 21 June 1988.

a listing of the names of all files on the tape is provided as Appendix C.

5.0 CONCLUSIONS

All TUPS and TESS data collected from the NORDA Panama City experiment has been processed, merged, and placed in a form amenable for further analysis. The data set is relatively complete, as we were able to recover the data "lost" due to a ship power failure on June 20, 1988. From the combined TUPS/TESS data, we produced large-scale time series plots showing all variables. These plots are excellent tools for examining the quality of the data set and for taking a quick look at parameter-parameter relationships. All light data appear to be of high quality, with the possible exception of the 488 nm downwelling light data. The TUPS depth sensor seemed to work exceptionally well.

The TUPS/TESS system appears to be quite useful for examining the optical-depth relationship in shallow water. Water depth can be inferred from measurements of upwelling irradiance under some conditions. Preliminary examination of this data set indicates the relationship holds well in areas of bright sand (e.g. south of Shell Island), but the relation of light to depth is more complicated in variable bottom and water clarity conditions. The broad suite of light and water quality sensors in TUPS makes it ideal for resolving such problems.

6.0 REFERENCES

Arnone, R.A. and D.A. Wiesenburg. 1988. Upwelling irradiance distribution across frontal zones and implications to ocean processes. Proc. of the Inter. Soc. Opt. Eng. (SPIE), Ocean Optics IX 925: 124-130.

Rein, C.R., D.A. Wiesenburg and D.M. Lavoie. 1985. A towed instrument vehicle for deep ocean sampling. Naval Ocean Research and Development Activity, NSTL, MS. NORDA Report 90, 48 pp.

7.0 ACKNOWLEDGEMENTS

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APPENDIX A

COMPUTER PROGRAM LISTINGS

 40

```
C*********************************************************************
C
C PROGRAM      CONVRT88
C
C PURPOSE      1) reads in raw TUPS data files in hex
C
C              2) converts data to engr. units with proper calib.
C
C AUTHOR       D.A.WIESENBURG
C
C DATE         2/9/88
C
C REVISION      NORMAN GUINASSO
C              DEC. 88
C
C      INPUT FILE IS GIVEN AND OUTPUT FILE OF SAME NAME.CNV PRODUCED
C
C
C**********************************************************************
C
      CHARACTER*3 MONTH
      CHARACTER*8  CHTIME,HHMMSS
      CHARACTER*9  CHDATE,DDMMYY
       CHARACTER*30 FILEN
       CHARACTER*34 CNVDAT,RAWDAT
       CHARACTER*60 RRAW
      CHARACTER*76 BUFFER
       CHARACTER*4 ANALG(8)
       CHARACTER*6 FRQ(8)

      REAL*4 V(8)
      REAL*8 TIME1(10000),TIMEA(10000)

      INTEGER*4 STR$FIND_FIRST_IN_SET
      COMMON /DAYS/ IDAY,IMON,IYR,jhr,jmin
      COMMON /DATIM/ CHDATE,CHTIME
       COMMON / RAW / ANLG,FRQ
       COMMON / DAY / DMY,HMS
       COMMON / CNVRT / COND,SAL78,TEMP,VOLT,FREQ,XL4,XL8,PSI,
     1                  DEPTH,TRANS,TLIGHT,CHLA,MINUTE,RTIME
C
      oldv5=1.0       ! initialize value used for fluor. sig. cleaning

       WRITE(6,100)
  100  FORMAT('  ENTER FILENAME FOR CURRENT RUN',/,
     1        '  INCLUDING EXTENSION (<= 30 CHARS)',/)
       READ(*,'(a)') FILEN
      rawdat=filen
      call chg_ext(rawdat,cnvdat,'UNF')
       OPEN(UNIT=18,FILE=RAWDAT,STATUS='OLD')
       OPEN(UNIT=19,FILE=CNVDAT,STATUS='NEW',form='unformatted',DISP='DELETE')
      call chg_ext(rawdat,cnvdat,'CNV')
C
      i=0
      do while(.true.)
              read(18,'(a)',iostat=ios) buffer
              if(ios.eq.-1) goto 200
              i=i+1
              J=STR$find_first_in_set(buffer,':')
              read(buffer(j-2:j+2),'(i2,1x,i2)') ih,im
              time1(i) = 60.d0*(60.d0*ih + im)
              jhr     =ih
              jmin    =im
c      the seconds are all 00 on TUPE data files
```

41

```
                j=str$find_first_in_set(buffer,'-')
                read(buffer(j-2:j+6),'(i2,1x,a3,1x,i2)') iday,month,iyr
                IMON = IDECMONTH(MONTH)
                inum=i
                RRAW = BUFFER(1:60)
                CALL CONVRT(RRAW,i)
        enddo

200             call timefix(time1,timea,inum)
                rewind(19)
                CALL DATE(DDMMYY)
                CALL TIME(HHMMSS)
        open(20,name=cnvdat,status='new',
     *   RECL=255,carriagecontrol='list')

         WRITE(20,150) CNVDAT,DDMMYY,HHMMSS
  150    FORMAT('  FILE: ',A35,5X,' CREATED: ',A9,2X,A8,/)
         WRITE(20,160)
  160    FORMAT(1X,4HDATE,5X,5HSTIME,4X,5HZTIME,5X,4HTEMP,3X,5HSAL78,
     1        4X,5H%TRAN,3X,6HCHL-FL,5X,5H465NM,3X,5H507NM,3X,5H532NM,
     2       3X,6HTRANSV,2X,6HFLSIGV,2X,6HFLSCLV,2X,6H488-UP,3X,5HDEPTH,/)
C     3        2X,7('-'),3X,8('-'),1X,5('-'),2X,5('-'),2X,6('-'),
C     4        2X,5('-'),2X,6('-'),2X,5('-'),2X,5('-'))

        DO WHILE (.TRUE.)
                read(19,end=500)
     *          i,IDAY,IMON,IYR,jhr,jmin,TEMP,SAL78,TRANS,CHLA,(V(K),K=1,8)
                write(20,1000,IOSTAT=IOS) iyr,imon,iday,timea(i),
     *                  jhr,jmin,
     *                  TEMP,SAL78,TRANS,CHLA,(V(K),K=1,8)
        ENDDO

500     close(20)
        CLOSE(UNIT=18)
         CLOSE(UNIT=19)
1000    FORMAT(I2.2,'/',I2.2,'/',I2.2,1x,f8.1,2x,i2.2,':',i2.2,':00',1x,
     *             F6.2,F8.3,F8.2,F9.2,1X,'|',6F8.3,F9.3,1X,F7.2)
      STOP
      END
!
        integer*4 function idecmonth(chr)
        character *(*) chr
        character*3 months(12)
        data months /   'JAN','FEB','MAR','APR','MAY','JUN',
     *                  'JUL','AUG','SEP','OCT','NOV','DEC'/
        call str$upcase(chr,chr)
        DO I=1,12
                IF(CHR.EQ.MONTHS(I)) THEN
                        IDECMONTH=I
                        RETURN
                ENDIF
        ENDDO
        TYPE *,' IDECMONTH-W-BAD MONTH'
        RETURN
        END

                SUBROUTINE CONVRT(RRAW,i)
C
C       CNVRT opens existing TUPS' data files, one at a time, and first
C       divides the strings into frequencies and analogs, then converts
C       the strings to various data parameters, which are written to
C       another output file.
c
C       modified at Texas A&M Univeristy by Guinasso and Wiesenburg
```

```
C      June 1988  -- for Panama City Cruise
C
C      CALLED FROM COLLCT AND CALLS CNVTLT AND PARSE
C
       CHARACTER*60 RRAW
       CHARACTER*4 ANLG(8)
       CHARACTER*6 FRQ(8)
       CHARACTER*8 CHTIME
       CHARACTER*9 CHDATE
       REAL        V(8)

       COMMON /DAYS/ IDAY,IMON,IYR,jhr,jmin
       COMMON / DATIM/ CHDATE,CHTIME
       COMMON / CNVRT / COND,SAL78,TEMP,VOLT,FREQ,XL4,XL8,PSI,
     1                DEPTH,TRANS,TLIGHT,CHLA,MINUTE,RTIME
       COMMON / RAW / ANLG,FRQ

       DATA XLFACT /0.121E17/
C
C -- Blank out the ANLG and FRQ arrays
C
        CALL ZERO
C
C -- Divides TUPS string into frequencies and analogs
C
        CALL DIVIDE(RRAW)

C
C -- Convert data parameters
C
        CALL CNVTMP    !temperature  - 1st frequency
        CALL CNVCND    !conductivity - 2nd frequency
C      CALL CNVPSI     !pressure     - 3rd frequency

C      FORWARD LIGHT SENSOR IN FIRST CHANNEL 0-5 VOLTS
       CALL CNVVLT(ANLG(1))
       V(1) = VOLT*2.0833       ! Factor for 2.4 volt/5 volt conv.
       V(1) = V(1)*10.9459      ! CAL. FACTOR FOR 465 LIGHT SENSOR 6/88
                                ! UNITS ARE uW/cm2/nm

C      MIDDLE LIGHT SENSOR IN SECOND CHANNEL 0-5 VOLTS
        CALL CNVVLT(ANLG(2))
       V(2) = VOLT*2.0833       ! Factor for 2.4 volt/5 volt conv.
       V(2) = V(2)*10.3644      ! CAL. FACTOR FOR 507 SENSOR 6/88
                                ! UNITS ARE uW/cm2/nm

C      AFT LIGHT SENSOR IN THIRD CHANNEL 0-5 VOLTS
        CALL CNVVLT(ANLG(3))
       V(3) = VOLT*2.0833       ! Factor for 2.4 volt/5 volt conv.
       V(3) = V(3)*9.8568       ! CAL FACTOR FOR 532 LIGHT SENSOR 6/88
                                ! UNITS ARE uW/cm2/nm

C      TRANSMISSOMETER IN FOURTH CHANNEL 0-5 VOLTS
        CALL CNVVLT(ANLG(4))
       V(4) = VOLT*2.0833       ! Factor for 2.4 volt/5 volt conv.
        TRANS=100.*((4.738/4.46)*(V(4)-.001))/5.      ! SENSOR #165

C      FLUOROMETER SIGNAL IS FIFTH CHANNEL 0-10 VOLTS
        CALL CNVVLT(ANLG(5))
       V(5) = VOLT*4.1667       ! Factor for 2.4 volt/10 volt conv.

C      check for bad fluorometer voltage and replace if bad
       if (v(5) .gt. 9.0) then
               v(5)=oldv5
```

```
      end if
      oldv5=v(5)

C     FLUOROMETER SCALE IS SIXTH CHANNEL 0-10 VOLTS
      CALL CNVVLT(ANLG(6))
      V(6) = VOLT*4.1667       ! Factor for 2.4 volt/10 volt conv.

C     CALCULATE REL. FLUORENCE USING SIGNAL AND SCALE VALUES
      CHLA=V(5)*(2.0**ININT(V(6)))     ! Make scale volts an integer

C     UP LOOKING LIGHT SENSOR IS EIGHTH CHANNEL 0-10 VOLTS
C     UNITS OF uW/cm3/nm
      CALL CNVVLT(ANLG(7))
      V(7) = VOLT*4.1667       ! Factor for 2.4 volt/10 volt conv.
      V(7) = EXP(V(7)-0.900)*5.88      ! 448 LOG SENSOR USUALLY IN TESS
C     **** THIS IS DIFFERENT THAN ALL OTHER TUPS CRUISES  *****

C     ECHO SOUNDER IS SEVENTH CHANNEL 0-10 VOLTS
      CALL CNVVLT(ANLG(8))
      V(8) = VOLT*4.1667       ! Factor for 2.4 volt/10 volt conv.
      V(8) = (V(8)*10.0)+1.0   ! meters=volts*10 + 1.0 m tow depth

       WRITE(19)
     * i,IDAY,IMON,IYR,jhr,jmin,TEMP,SAL78,TRANS,CHLA,(V(K),K=1,8)

       RETURN
       END



       SUBROUTINE ZERO

      CHARACTER*6 F(8)
      CHARACTER*4 A(8)

       COMMON / RAW / A,F

      DO 10 J=1,8
        F(J) = ' '
         A(J) = ' '
   10  CONTINUE

       RETURN
       END



       SUBROUTINE   HEXDEC(F)

       CHARACTER*4 O
      CHARACTER*6 F
       INTEGER*2 G
      CHARACTER*1 CM,NUM

       COMMON / CNVRT / COND,SAL78,TEMP,VOLT,FREQ,XL4,XL8,PSI,
     1                DEPTH,TRANS,TLIGHT,CHLA

       CM = F(1:1)
       XM = XMULT(CM)

       IF (XM.NE.0.) THEN
         DO 50 I=3,6
           O(I-2:I-2) = F(I:I)
   50    CONTINUE
```

```
      LENGTH = 4
      XN = 0.
      P = 1.
      DO 100 I=LENGTH,1,-1
        G=ICHAR(O(I:I))
        IF(G.GT.64) THEN
           D=FLOAT(G)-55.
        ELSE
           NUM = O(I:I)
          IF (NUM.EQ.'0') D = 0.  ! ADDED BY K.D.SAUNDERS 9/25/86
           IF (NUM.EQ.'1') D = 1.
           IF (NUM.EQ.'2') D = 2.
           IF (NUM.EQ.'3') D = 3.
           IF (NUM.EQ.'4') D = 4.
           IF (NUM.EQ.'5') D = 5.
           IF (NUM.EQ.'6') D = 6.
           IF (NUM.EQ.'7') D = 7.
           IF (NUM.EQ.'8') D = 8.
           IF (NUM.EQ.'9') D = 9.
C           D=FLOAT(G)
        END IF
        XN=XN+D*P
        P=P*16.
  100 CONTINUE
      FREQ=10.0E06*XM/XN
    ELSE
      FREQ=0.
   END IF
C
C*** END OF SUBROUTINE HEXDEC
C
    RETURN
    END




      FUNCTION XMULT(CM)
C
      CHARACTER*1 CM
C
      IF(CM.EQ.'0') THEN
         XMULT=253.
      ELSE IF(CM.EQ.'1') THEN
         XMULT=126.
      ELSE IF(CM.EQ.'2') THEN
         XMULT=84.
      ELSE IF(CM.EQ.'3') THEN
         XMULT=63.
      ELSE IF(CM.EQ.'4') THEN
         XMULT=50.
      ELSE IF(CM.EQ.'5') THEN
         XMULT=42.
      ELSE IF(CM.EQ.'6') THEN
         XMULT=36.
      ELSE IF(CM.EQ.'7') THEN
         XMULT=31.
      ELSE IF(CM.EQ.'8') THEN
         XMULT=28.
      ELSE IF(CM.EQ.'9') THEN
         XMULT=25.
      ELSE IF(CM.EQ.'A') THEN
         XMULT=23.
```

```
      ELSE IF(CM.EQ.'B') THEN
         XMULT=21.
      ELSE IF(CM.EQ.'C') THEN
         XMULT=19.
      ELSE IF(CM.EQ.'D') THEN
         XMULT=18.
      ELSE IF(CM.EQ.'E') THEN
         XMULT=16.
      ELSE IF(CM.EQ.'F') THEN
         XMULT=15.
      ELSE
         XMULT=0.
         WRITE(6,*) CM,' *NO MULTIPLIER CALCULATED, XMULT SET TO ZERO'
      END IF
C
C*** END OF FUNCTION XMULT
C
      RETURN
      END




        SUBROUTINE CNVTMP

       CHARACTER*4 ANLG(8)
       CHARACTER*6 FRQ(8)

        COMMON / RAW / ANLG,FRQ
        COMMON / CNVRT / COND,SAL78,TEMP,VOLT,FREQ,XL4,XL8,PSI,
     1                   DEPTH,TRANS,TLIGHT,CHLA
C
C       SEA BIRD CALIBRATION DATA FOR SENSOR #632
C
C     DATA A /3.67517928E-03/, B /6.01320919E-04/,      ! SEABIRD SENSOR
C    1     C /1.59454020E-05/, D /2.59063611E-06/       ! #632
C     DATA FO /6092.84/, XK /273.15/

C       SEA BIRD CALIBRATION DATA FOR SENSOR #638 --  9-18-87 CAL.
C
      DATA A /3.67399029E-03/, B /6.01229226E-04/,      ! SEABIRD SENSOR
     1     C /1.51578463E-05/, D /2.71329547E-06/       ! #638
      DATA FO /6337.28/, XK /273.15/



      CALL HEXDEC(FRQ(1))

      IF(FREQ.NE.0.) THEN
         DIV=ALOG(FO/FREQ)
         T1=A+B*DIV
         T2=C*DIV**2
         T3=D*DIV**3
         TEMP=1./(T1+T2+T3)-XK
      ELSE
         TEMP=0.
      END IF
C
C***  END OF SUBROUTINE CNVTMP
C
      RETURN
      END
```

```
      SUBROUTINE CNVCND

      CHARACTER*6 FRQ(8)
      CHARACTER*4 ANLG(8)
      REAL        IEXP

      COMMON / RAW / ANLG,FRQ
      COMMON / CNVRT / COND,SAL78,TEMP,VOLT,FREQ,XL4,XL8,PSI,
     1               DEPTH,TRANS,TLIGHT,CHLA

C     SEA BIRD CALIBRATION DATA SENSOR #267
C
C     DATA W /4.43054668E-10/, X /5.20135966E-01/,   ! SEA BIRD SENSOR
C    1   Y /-4.36199682/, Z /2.42254149E-04/         ! SENSOR #267
C     DATA IEXP /8.4/

C     SEA BIRD CALIBRATION DATA SENSOR #234 -- 9-18-87 CAL.
C
      DATA W /8.88229858E-09/, X /5.1687217E-01/,    ! SEA BIRD SENSOR
     1   Y /-4.37109279/, Z /-4.80212277E-05/              ! SENSOR #234
      DATA IEXP /7.2/

      CALL HEXDEC(FRQ(2))

      F=FREQ/1000.
      C1=W*F**IEXP
      C2=X*F**2
      C3=Y
      C4=Z*TEMP
      COND=C1+C2+C3+C4

      CALL SALNTY
C

C***  END OF SUBROUTINE CNVCND
C
      RETURN
      END




      SUBROUTINE SALNTY

      COMMON / CNVRT / COND,SAL78,TEMP,VOLT,FREQ,XL4,XL8,PSI,
     *               DEPTH,TRANS,TLIGHT,CHLA

      T=TEMP
      P=2.           ! HARD CODED FISH DEPTH FOR SAL CALC.
      SAL78=0.

      IF(COND.GE.0.0005) THEN
        DT=T-15.
        R=COND/42.914
        RT35=(((.10031E-08*T-.69698E-06)*T+.0001104259)*T
     1       +.200564E-01) * T+.6766097
        RT=R/(RT35*(1.+FNC(P)/(FNB(T)+FNA(T)*R)))
        RT=SQRT(ABS(RT))
```

```
          XR=RT
          XT=DT
          S1=((((2.7081*XR-7.0261)*XR+14.0941)*XR+25.3851)*XR-.1692)*XR
          S2=.008
          S3=XT/(1.+.0162*XT)
          S4=((((-.0144*XR+.0636)*XR-.0375)*XR-.0066)*XR-.0056)
     1       *XR+.0005
          SAL78=S1+S2+S3*S4
        END IF
C
C***  END OF SUBROUTINE SALNTY
C
      RETURN
      END







        SUBROUTINE CNVPSI

       CHARACTER*4 ANLG(8)
       CHARACTER*6 FRQ(8)

        COMMON / RAW / ANLG,FRQ
        COMMON / CNVRT / COND,SAL78,TEMP,VOLT,FREQ,XL4,XL8,PSI,
     1                DEPTH,TRANS,TLIGHT,CHLA

        DATA C /-57083.99/, D /0.03636303/, TO /27.597905/,
     1     G /6.894759E7/, H /10.0E-6/, XLAT /36.0/

        CALL HEXDEC(FRQ(3))
        F=FREQ

        PSI=G*(C*(1.-(H*TO*F)**2))*(1.-D*(1.-(H*TO*F)**2))

        X=SIN(XLAT/57.29578)
        X=X**2

        GRAVTY=9.780318*(1.+(5.2788E-3+2.36E-5*X)*X)+1.092E-6*PSI
        DEPTH=(((-1.82E-15*PSI+2.279E-10)*PSI-2.2512E-5)*PSI+9.72659)*PSI
        DEPTH=DEPTH/GRAVTY

        RETURN
        END



       FUNCTION FNC(XP)
C
       FNC=((.3989E-14*XP-.637E-09)*XP+.207E-04)*XP
C
C***  END OF FUNCTION FNC
C
        RETURN
        END
```

```
      FUNCTION FNB(XT)

      FNB=(.4464E-03*XT+.03426)*XT+1.
C
C***  END OF FUNCTION FNB
C
      RETURN
      END



      FUNCTION FNA(XT)
C
      FNA=-.003107*XT+.4215
C
C***  END OF FUNCTION FNA
C
      RETURN
      END



      SUBROUTINE CNVVLT(AN)

      CHARACTER*4 O,AN
      CHARACTER*1 NUM
      INTEGER*2 G

      COMMON / CNVRT / COND,SAL78,TEMP,VOLT,FREQ,XL4,XL8,PSI,
     1                 DEPTH,TRANS,TLIGHT,CHLA

C     REFERENCE VOLTAGE -- VREF -- FOR TUPS COMPUTER

C      DATA VREF /1.23536/            ! ONE COMPUTER OLD

      DATA VREF /1.233/               ! OTHER COMPUTER NEW -- USED 6/88

      O = AN
      LENGTH=4
      XN=0.
      P=1.

      DO 100 I=LENGTH,2,-1
        G = ICHAR(O(I:I))
        IF(G.GT.64) THEN
          D=FLOAT(G)-55.
        ELSE
          NUM = AN(I:I)
          IF (NUM.EQ.'0') D = 0.      ! ADDED BY ARNONE 2-5-1988
          IF (NUM.EQ.'1') D = 1.
          IF (NUM.EQ.'2') D = 2.
          IF (NUM.EQ.'3') D = 3.
          IF (NUM.EQ.'4') D = 4.
          IF (NUM.EQ.'5') D = 5.
          IF (NUM.EQ.'6') D = 6.
          IF (NUM.EQ.'7') D = 7.
          IF (NUM.EQ.'8') D = 8.
          IF (NUM.EQ.'9') D = 9.
        END IF
C
        XN=XN+D*P
```

```
          P=P*16.
  100   CONTINUE
C
        VOLT=XN*VREF/2048.
        IF (AN(1:1).EQ.'C') VOLT=-VOLT
C
C***  END OF SUBROUTINE CNVVLT
C
        RETURN
        END





      SUBROUTINE DIVIDE(RRAW)
C
C****
C****
C
C   SUBROUTINE DIVIDE SEPARATES THE INPUT STRING FROM TUPS
C   INTO FREQUENCY AND ANALOG CHANNEL OUTPUT
C
C   VARIABLES:
C
C      FRQ - ARRAY TO HOLD FREQUENCY DEFINING STRINGS
C      ANLG - ARRAY TO HOLD ANALOG DEFINING STRINGS
C
C   CALLING PROGRAM(S) :
C
C      PROGRAM CNVRT
C
C****
C****
C

       CHARACTER*(*) RRAW
       CHARACTER*4   ANLG(8)
       CHARACTER*6   FRQ(8)
       CHARACTER*80  OUTSTR(12)
       LOGICAL*1     ILOG(1600)
       EQUIVALENCE   (ILOG(1),OUTSTR)
       INTEGER       LSTR(20)


        COMMON / RAW / ANLG,FRQ

       CALL PARSE(RRAW,OUTSTR,NSTR)

       NFRQ = 0
       NANAL= 0
       DO I = 1,NSTR
               LSTR(I) = INDEX(OUTSTR(I),' ')-1
               IF(LSTR(I) .GT. 1) THEN
               IF(I.GT.1 .AND. LSTR(I-1) .EQ. 1 )THEN
                  NFRQ = NFRQ + 1
                  FRQ(NFRQ) = OUTSTR(I-1)(1:1)//' '//OUTSTR(I)(1:4)
                 ELSE
                  NANAL = NANAL + 1
                  ANLG(NANAL) = OUTSTR(I)(1:4)
               END IF
               END IF
       END DO
```

```
      RETURN
       END
C
C
C SUBROUTINE   PARSE(INSTRING,OUTSTR,N)
C
C PURPOSE      BREAKS A STRING INTO AN ARRAY OF CHARACTER STRINGS
C              WITH EACH BEING ONE ELEMENT OF A LIST. LIST
C              SEPARATORS ARE COMMAS AND/OR BLANKS
C
C PARAMETERS   INSTRING - A CHARACTER STRING
C              OUTSTR   - AN ARRAY OF CHARACTER*80 BY 10
C              N        - NUMBER OF SUBSTRINGS FOUND
C
C


      SUBROUTINE PARSE(INSTRING,OUTSTR,N)


      CHARACTER*(*)   INSTRING,OUTSTR(*)
      INTEGER         N,PTR,DPTR
      LOGICAL         MORE,BLANK,COMMA

      MORE  = .TRUE.
      PTR   =  0
      N = 0
      DO WHILE( MORE )

              IBLANK = INDEX(INSTRING(PTR+1:),' ')
              ICOMMA = INDEX(INSTRING(PTR+1:),',')
              IQUOTE = INDEX(INSTRING(PTR+1:),'''')
                      DPTR = MIN(IBLANK,ICOMMA)
                      IF(IBLANK.EQ.0) DPTR =ICOMMA
                      IF(ICOMMA.EQ.0) DPTR =IBLANK

C             TYPE *,'IQUOTE = ',IQUOTE
C             TYPE *,'DPTR,IBLANK,ICOMMA=',DPTR,IBLANK,ICOMMA


              IF(IQUOTE .NE. 0 .AND. IQUOTE .LT. DPTR )THEN
               NQUOTE=INDEX(INSTRING(PTR+IQUOTE+1:),'''')+IQUOTE

               IF(NQUOTE.EQ.IQUOTE) THEN
                 IQUOTE=0
                ELSE
                 IBLANK=INDEX(INSTRING(PTR+NQUOTE+1:),' ')+NQUOTE
                 ICOMMA=INDEX(INSTRING(PTR+NQUOTE+1:),',')
                 IF(ICOMMA .NE. 0) ICOMMA=ICOMMA+NQUOTE
               END IF
C              TYPE *,'IQUOTE,NQUOTE,IBLANK,ICOMMA,PTR'
C              TYPE *,IQUOTE,NQUOTE,IBLANK,ICOMMA,PTR
              ELSE
               IQUOTE = 0
C              TYPE *,'IQUOTE,NQUOTE,IBLANK,ICOMMA,PTR'
C              TYPE *,IQUOTE,NQUOTE,IBLANK,ICOMMA,PTR
              END IF


              BLANK = .TRUE.
              DO I = PTR+1,80
                      IF(INSTRING(I:I) .NE. ' ') THEN
                              BLANK= .FALSE.
```

```
                                GOTO 1000
                        END IF
                END DO
1000            CONTINUE
                IF(BLANK) IBLANK=0
                IF(IBLANK .EQ. 0 .AND. ICOMMA .EQ. 0) THEN
                        MORE = .FALSE.
                 ELSE
                        COMMA = .FALSE.
                        DPTR = MIN(IBLANK,ICOMMA)
                        IF(IBLANK.EQ.0) DPTR =ICOMMA
                        IF(ICOMMA.EQ.0) DPTR =IBLANK
                        IF(ICOMMA .EQ. DPTR) COMMA = .TRUE.
                        N = N + 1
                        IF(COMMA .AND. DPTR .EQ. 1) THEN
                          OUTSTR(N) = ' '
                          PTR=PTR+1
                        ELSE
                         OUTSTR(N)=INSTRING(PTR+1:PTR+DPTR-1)

                         IF(IQUOTE.NE.0) THEN
                          OUTSTR(N)=INSTRING(PTR+1+IQUOTE:PTR+NQUOTE-1)
                         END IF

C                                TYPE *,N,IBLANK,ICOMMA,OUTSTR(N)
                         PTR=PTR+DPTR
                         IF(OUTSTR(N) .EQ. ' ') N=N-1
                        END IF
                END IF
        END DO
        RETURN
        END



!
        subroutine timefix(time,timea,n)
        real*8 time(n),timea(n)
        real*8 dt
        inum=n
        do i=1,15
                type *,i,time(i)
                if(time(i).eq.time(i+1) ) then
                else
                        kks=i+1
                        goto 30
                endif
        enddo
30      continue
        do ii=1,15
                i=inum-ii+1
                type *,i,time(i)
                if(time(i).eq.time(i-1)) then
                else
                        kke=i
                        goto 31
                endif
        enddo
31      nt = kke - kks

        dt= (time(kke) - time(kks))/float(nt)
        type *,nt,dt
        timea(kks)=time(kks)
        do i=kks-1,1,-1
                timea(i)=timea(i+1)-dt
```

```
        enddo
        do i=kks+1,inum
                timea(i)=timea(i-1)+dt
        enddo
        return
        end
!
        subroutine sec_to_hms(ts,ih,im,is)
        implicit real*8 (t)
                ih=ts/3600.
                tl=ts-ih*3600.
                im=tl/60.
                tl=tl-im*60.
                is=tl
        return
        end
```

```
----.----:----.----:----.----:----.----:----.----:----.----:----.----:----.----:
C*****************************************************************
C
C PROGRAM      READJUN
C
C PURPOSE      1) program readjun to deal with tess files
C
C              2) place tess file in appropiate structure
C
C AUTHOR       NORMAN GUINASSO
C
C DATE         JUNE 88
C
C REVISION      DEC. 88
C
C
C
C*******************************************************************
C
      implicit real*8 (d)
      real*8 ttime,flatd,flatm,flats,flond,flom,flons
      real*8 d60 /60.d0/
      REAL*4 V(11),spd

      CHARACTER*21 DATELINE
      CHARACTER*80 dataline
      character*80 naviline
      character*40 logname
      character*20 cdate
!
      type '('' Program to read and translate TESS files    '')'
      type '('' Enter input file name => '',$)'
      accept '(a)',logname
      cdate=' '                   ! put date and time into string cdate
      call date(cdate)
      call time(cdate(12:))
! open files
      open(9,name=logname,readonly,status='old',err=999)
      call chg_ext(logname,logname,'rdj')
      open(11,carriagecontrol='list',status='new',name=logname,recl=255)
      type '('' Output file will be called '',a)',logname
!-------------------------------------------------------------------------
      write(11,'(''TESS data processed by program r  djun on '',a)')cdate
      write(11,'(''TESS data are 2.5VREF, 441 NM, 488 NM, PYRO1,PYRO2 -
     *  FILENAME = '',a)')logname
      icnt=0
      do while (.true.)
              read(9,'(a)',iostat=ios) dateline
              if(ios.eq.-1) goto 100          ! if end of file
              icnt=icnt+1
              j=str$translate(dateline,dateline,' ','-:')
              read(dateline,*,iostat=jos) mon,iday,iyear,ih,im,is
              if(jos.ne.0) type *,' read error on dateline string ',jos
              if(iyear.gt.1900) iyear=iyear-1900  ! limit to 20th century
              ttime=d60*d60*(ih +(is/d60 +im)/d60)! seconds since midnight

              if(mod(icnt,50).eq.1) type '(''+'',i5,2X)',icnt! preveNt boredom

              read(9,'(a)',iostat=ios) dataline
              read(9,'(a)',iostat=ios) naviline
              j=str$translate(naviline,naviline,'  ','NW') ! eliminate NW
              read(naviline,*,iostat=jos)flatd,flatm,flats,flond,flonm,flons,
     *                     ihdg,spd,td1,td2         ! get the numbers
              if(jos.eq.-1) goto 110  ! if they are not there, stop
              if(jos.ne.0) type *,' error reading naviline ',jos! signal
```

```
          dlat= flatd +(flats/d60 + flatm)/d60      ! decimal degrees
          dlon= flond +(flons/d60 + flonm)/d60      ! ditto
          dlon= -dlon                               ! occident
          j=str$trim(dataline,dataline,len)         ! remove trailing blanks

C     ROUTINE TO CONVERT VOLTS IN THE DATA LINE TO ENGINEERING UNITS
          READ(DATALINE,*,IOSTAT=KOS)(V(K),K=1,11)
          if(KOS.eq.-1) goto 115  ! if they are not there, stop
          CALL CALCENGR(V)

          write(11,300) iyear,mon,iday,ttime,ih,im,is, ! record for
     *         dlat,dlon,td1,td2,ihdg,spd,V(2),(V(K),K=5,8)  ! posterity
      enddo
100   type *,icnt, ' records'
      stop 'end of file'
110   stop 'unexpected end of file reading dataline'
115   stop 'unexpected end of file reading dataline FOR CALCULATION'
120   stop 'unexpected end of file reading naviline'
999   stop 'bad inputfile'
300   format(i2.2,'/',i2.2,'/',i2.2,1x,f8.1,2x,i2.2,':',i2.2,':',i2.2,1x,
     *       f11.6,f12.6,2f9.2,2x,i3.3,F5.1,5F7.3)
      end

      SUBROUTINE CALCENGR(V)
      REAL*4 V(11)
C     SUBROUTINE TO CONVERT TESS VOLTAGES TO ENGINEERING UNITS
C     THE VOLTAGE ARRAY "V" IS PASSED BACK AND FORTH

C     V(5) IS 441 LOG LIGHT SENSOR SN: 7102
C     UNITS ARE uW/cm2 sec nm
      V(5)=3.54*EXP(V(5)-0.734)

C     V(6) IS 488 LINEAR LIGHT SENSOR SN: 7105
C     UNITS ARE uW/cm2 sec nm
      V(6)=V(6)/0.25599

C     V(7) IS PYRO1 -- THE LIGHT BULB PYROHELIOMETER
C     UNITS ARE uW/cm2*10^4
      V(7)=(V(7)-0.0)/0.640                 ! CONVERT VOLTS TO MILLIVOLTS
      V(7)=V(7)*(0.1202/60.0)*4.184*100.0 ! CALIBRATION AND CONVERSION

C     V(8) IS PYRO2 -- THE HEMISPHERE PYROHELIOMETER
C     UNITS ARE uW/cm2*10^4
      V(8)=(V(8)-0.0)/0.9719                ! CONVERT VOLTS TO MILLIVOLTS
      V(8)=V(8)*(0.2232/60.0)*4.184*100.0 ! CALIBRATION AND CONVERSION

C**   END OF SUBROUTINE CALCENGR
      RETURN
      END
```

```
C**********************************************************************
C
C PROGRAM       PRETABLE
C
C PURPOSE       1) reads in tups "cnv" file
C
C               2) filters some data and writes a binary file
C
C AUTHOR        NORMAN GUINASSO
C
C DATE          JUNE 88
C
C REVISION      DEC. 88
C
C
C**********************************************************************
C
        parameter (nn=5000)
        common /fopen_name/ f_name
        character*60 f_name,filename,outfile
!  datatups variables:
        equivalence (datatups(1, 1), temp(1))
        equivalence (datatups(1, 2), salin(1))
        equivalence (datatups(1, 3), ptrans(1))
        equivalence (datatups(1, 4), fluor(1))
        equivalence (datatups(1, 5), d465nm(1))
        equivalence (datatups(1, 6), d507nm(1))
        equivalence (datatups(1, 7), d532nm(1))
        equivalence (datatups(1, 8), transv(1))
        equivalence (datatups(1, 9), flsigv(1))
        equivalence (datatups(1,10), flsclv(1))
        equivalence (datatups(1,11), d488up(1))
        equivalence (datatups(1,12), dep(1))
!
        real*8 datatups(nn,12)
        real*8 temp(nn),salin(nn),ptrans(nn),transv(nn)
        real*8 fluor(nn),flsigv(nn),flsclv(nn)
        real*8 d465nm(nn),d507nm(nn),d532nm(nn),d488up(nn)
        real*8 dep(nn)
!-----------------------------------------------------------------
        real*8 rawdepth(nn)
        real*8 rawfluor(nn)
        real*8 ddint(11)
        real*8 data(nn,11)
        real*8 ttime(nn)
        real*8 out(nn)
        character*150 in
        character*8 ctime,timestr
        character ans
        character*30 timedate,filedate
!  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        call date(timedate(11:))
        call time(timedate(21:))
        timedate(1:10)= 'Processed'

        type *, ' Preprocessor for TUPS file '
        type *, ' This program filters fluorescence, % trans, depth, salinity'
        type * ,' and writes a binary file'
        call fopenread(10)
        type *, '  '
        i=0
        do while(.true.)
                read(10,'(a)',iostat=ios) in
                if(ios.eq.-1) goto 290
```

```
                i=i+1
                if(mod(i,100).eq.1) type '(''+.'',$)'
                j=str$translate(in,in,'   ',':/|')
                j=str$trim (in,in,len)
                read(in(1:len),*,iostat=ios)
     *          iyr,imo,iday,ttime(i),ihr,imin,isec,
     *          (datatups(i,j),j=1,12)
                if(i.gt.1) then
                if( ttime(i) .lt. ttime(i-1) ) then
                        i=i-1
                        type *,' bad time at ', i,ttime(i-1)
                        type *,in(1:70)
                endif
                endif

                if(ios.ne.0) then
                        i=i-1
                        type *,ios,' ',in(1:66)
                else
                endif
        enddo
290     continue
        ncnt=i
        do i=1,ncnt
                rawdepth(i)=dep(i)
                rawfluor(i)=fluor(i)
        enddo
!
        write(filedate,104) iyr,imo,iday
104     format('filedate ',i2,'/',i2.2,'/',i2.2)
!------------------------------------------------------------------
        type *,ncnt
        type *, ' salinity '
        call rfilter(salin,ncnt, .03,  2.1 ,   30.,   37.)
        pause
        type *, ' percent trans'
        call rfilter(ptrans,ncnt, .1,   6. ,   60.,  100.)
        pause
        type *, ' depth '
        call rfilter(dep,ncnt,    .3,   5. ,    0.,   30.)
        pause
!------------------------------------------------------------------
        type *, 'fluorescence'
        f=.5
        fmin=100.
        fmax=850.
        call rfilter ( fluor, ncnt, f, 65., fmin, fmax )
!------------------------------------------------------------------
!
d       open(15,name='plotfluor.out',status='new',carriagecontrol='list')
d       write(15,'(f7.3,3f7.1)')
d    #   (ttime(i)/3600.,rawfluor(i),rawdepth(i),fluor(i),i=1,ncnt)
d       close(15)
        call chg_ext(f_name,outfile,'pto')

        open(unit=14,name=outfile,status='new',iostat=jos,
     *          form='unformatted',carriagecontrol='none')
        type *,jos,' '//outfile
        write (14) timedate,filedate,ncnt
        type *, ' ncnt ',ncnt
        do i=1,ncnt
                write(14) ttime(i),(datatups(i,j),j=1,12)
        enddo
        close(14)
```

```
        stop
100     format('+.',$)
101     format(6i3.2,1x,a,1x,f8.1,3(/,8f10.2))
103     format(f9.4,2f8.1)
        end
!
        subroutine rfilter(d,n,f,windowmin,fmin,fmax)
! windowing filter
! if new point differs by previous point times f then old point is retained
! also if point out of range fmin,fmax than previous point is retained
! guinasso, circa 1988
        real*8 f,windowmin,fmin,fmax
        real*8 d(n)
        real*4 ave , sdev
        type *, ' rfilter-i-f= ',f,windowmin
        type *, ' rfilter-i-fmin,fmax= ',fmin,fmax
        call stat(d,n,ave,sdev)
        ichanged = 0
        tm1=0
        tm2=0
        do i=2,n
                tm3=tm2
                tm2=tm1
                tm1=t
                t=d(i)
                prev = d(i-1)
                if(prev.lt.fmin .or. prev.gt.fmax) then
                        prev = ave
                        type *,' prev replaced with average = ',ave
                endif
                delta  = abs(d(i) - prev)
                window  = f * prev
                if(window.lt.windowmin) window=windowmin
                if(delta.gt.window .or. d(i).lt.fmin .or. d(i).gt.fmax) then
                        d(i) = prev
                        TYPE '(1x,2f8.2,4f8.1,
     #                          '' changed '',i5,'' to '',f8.1)',
     #                          window,delta,tm3,tm2,tm1,t,i,d(i)
                        ichanged = ichanged + 1
                else
                endif
        enddo
        return
        end
!
        subroutine table_lookup (x,y,n,nn,m,xx,yy,reset)
! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
! linear interpolation lookup program
! guinasso circa 1988
! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
!       n       dimension of x,y
!       nn      number actually used
        real*8 x(n)     ! array of x's must be monotonically increasing
        real*8 y(n,m)   ! array of y's
        real*8 xx       ! x value at point to look up
        real*8 yy(m)    ! y's at xx (returned)
        real*8 f        ! interpolation fraction
        integer*4 i1 /1/! start of interpolation range
        logical reset   ! will reset range looked at to  1 thru n
!
        if (reset) i1=1
        if(xx.lt. x(1) ) goto 10        ! not on table
        do i=i1,n-1
                if(x(i).ge.x(i+1)) then
```

```
                        stop 'table_lookup-f-bad table, not monotonic'
                else if(xx.ge.x(i) .and.xx.le.x(i+1)) then
                        n1=i
                        n2=i+1
                        i1=n1
                        goto 20
                endif
        enddo
10      continue
                type *, 'table_lookup-i-xx not on table '
                type *,  xx,x(1),x(n)
        return
!
20      f = (xx-x(n1) )/( x(n2)-x(n1) )
        wf = 1.d0-f
        do j=1,m
                yy(j) = wf*y(n1,j) + f*y(n2,j)
        enddo
        return
        end
!
        character*8 function timestr(secs)
! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
! converts seconds past midnight to HH:MM:SS
! guinasso circa 1988
! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        ih=secs/3600
        im=(secs - ih * 3600.)/60.
        is=nint(secs -ih * 3600. - im * 60.)
        write (timestr,'(i2.2,'':'',i2.2,'':'',i2.2)' ) ih,im,is
        return
        end
!-----------------------------------------------------------------------
        subroutine stat(y,n,aver,sdev)
! calculates mean and standard deviation of array y
        real*8 y(n)
        sum=0.
                do i=1,n
                        sum=sum+y(i)
                enddo
                aver = sum/float(n)
                sum=0.
                do i=1,n
                        sum=sum+ (aver-y(i))**2
                enddo
                var = sum/float(n-1)
                sdev = sqrt(var)
                type *,'stat-i-mean, standard deviation = ', aver,sdev
                return
        end
!-----------------------------------------------------------------------
```

```
C***********************************************************************
C
C PROGRAM       MERGETT
C
C PURPOSE       1) merge norda tess tups files
C
C AUTHOR        NORMAN GUINASSO
C
C DATE          JUNE 88
C
C               DEC. 88
C
C SUBROUTINES
C
C
C
C*************************************************************************
C
! Geocemical and Environmental Resaearch Group
! Texas A&M University
!%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
        parameter (nn=5000)
        parameter (nnn=25000)
!
        common /fopen_name/ f_name
        character*60 f_name,outfile,infile
        character*150 in
        real*8 ddint(11)
        real*8 data(nn,11)
        real*8 datatups(nnn,12)
        real*8 attime(nnn)
        real*8 time(nn),ttime
        character*8 ctime,timestr
        character*30 timedate,filedate
!  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        call lib$init_timer()
        type *, ' tess file '
        call fopenread(9)
!

! for tups file
        call chg_ext(f_name,infile,'pto')
        type *,' Opening TUPS pretable output file ',infile
        open (14, name=infile,form='unformatted',status='old',iostat=jos)
        if(jos.ne.0) stop 'file not found'
!
! output file
        call chg_ext(f_name,outfile,'fin')
        type *,' Output file will be called ',outfile
        type *,' '
! for tess file
        do while(.true.)
                read(9,'(a)',iostat=ios) in
                if(ios.eq.-1) goto 90
                i=i+1
                j=str$translate(in,in,'  ',':/')
                read(in,*,iostat=ios)
     *          iyr,imo,iday,time(i),ih,im,is,(data(i,j),j=1,11)
                if(ios.ne.0) then
                        type *,in(1:76)
                        i=i-1
                endif
                if(mod(i,100).eq.1) type 100
        enddo
```

```
90      nctess=i
        close(9)
        type *, nctess, ' records in tess file '
        type *,time(1),time(nctess), ' are start stop times'
        call lib$show_timer ( )
        read (14) timedate,filedate,nctup
        type *,   nctup,'  ',timedate,filedate
        do i=1,nctup
                k = i
                read(14,end=92) attime(i),(datatups(i,j),j=1,12)
        enddo
        goto 93
92      type *,' end of tups file ',k,nctup
        if(k.ne.nctup) type *, 'bad tups file'
93      close(14)
        call lib$show_timer()
!
!
        type *,' starting output phase'
        type *,' '
        open(15,name=outfile,carriagecontrol='list',status='new',
     *     recl=256)
        iout=0
        do i=1,nctup
                if(mod(i,100).eq.0) type 100
                ttime = attime(i)
                call table_lookup(time,data,nn,nctess,11,
     *                  ttime,ddint,.false.)
                ctime=timestr(ttime)
                iout=iout+1
                write(15,101)iyr,imo,iday,ctime,
     *                  ttime,ddint,(datatups(i,j),j=1,12)
        enddo
        call lib$show_timer()
        stop
100     format('+.',$)
101     format(3i3.2,1x,a,1x,f8.1,f10.6,f11.6,2f10.2,f6.1,f5.2,
     *  5f7.3, f6.2, f7.3, f6.2, f9.2, 7f7.3, f6.2)
! tess
! F lat,long,td1,td2,heading,speed,2.5 ref,data 1-4
! S temp, sal, ptrans, chlorfl, data 1-7, depth
        end
!
        subroutine table_lookup (x,y,n,nn,m,xx,yy,reset)
! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
! linear interpolation lookup program
! guinasso circa 1988
! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
!       n       dimension of x,y
!       nn      number actually used
        real*8 x(n)     ! array of x's
        real*8 y(n,m)   ! array of y's
        real*8 xx       ! x to look up
        real*8 yy(m)    ! y's at xx
        real*8 f        ! interpolation fraction
        integer*4 i1 /1/! start of interpolation range
        logical reset   ! will reset range looked at to  1 thru n
!
        if (reset) i1=1
        if(xx.lt. x(1) .or. xx.gt.x(nn)) goto 10       ! not on table
        do i=i1,nn-1
                if(x(i).ge.x(i+1)) then
                        type *, i,x(i),x(i+1)
                        stop 'table_lookup-f-bad table'
```

```
                endif
                if(xx.ge.x(i) .and.xx.le.x(i+1)) then
                        n1=i
                        n2=i+1
                        i1=n1
                        goto 20
                endif
        enddo
10      continue
                type *, 'table_lookup-i-xx not on table '
                type *,  xx,x(1),x(nn)
        return
!
20      f = (xx-x(n1) )/( x(n2)-x(n1) )
        wf = 1.d0-f
        do j=1,m
                yy(j) = wf*y(n1,j) + f*y(n2,j)
        enddo
        return
        end
!
        character*8 function timestr(secs)
! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
! converts seconds past midnight to HH:MM:SS
! guinasso circa 1988
! - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        ih=secs/3600
        im=(secs-ih*3600.)/60.
        is=nint(secs-ih*3600.-im*60.)
        write (timestr,'(i2.2,'':'',i2.2,'':'',i2.2)' ) ih,im,is
        return
        end
```

```
C*************************************************************************
C
C PROGRAM       TTPLOT
C
C PURPOSE       1) plots combined tess and tups data
C
C AUTHOR        NORMAN GUINASSO
C
C DATE          JUNE 88
C
C REVISION      DEC. 88
C
C
C*************************************************************************
        parameter(nn=5000)
        common /paper/ xpaper,ypaper,LASER
        common /xrange/ x1,x2
        LOGICAL LASER /.FALSE./
        real*4 time(nn)
        real*4 flat(nn)
        real*4 flon(nn)
        real*4 hdg(nn)
        real*4 speed(nn)
        real*4 flite1(nn),flite2(nn),flite3(nn),flite4(nn)
        real*4 temp(nn),salin(nn)
        real*4 ptrans(nn)
        real*4 fluor(nn)
        real*4 depth(nn)
        real*4 up1(nn),up2(nn),up3(nn),down1(nn)
        character*4 itime
        CHARACTER*300 IN
        character*60 t1,t2,t3,t4,t5,t6,t7,t8
        character*30 pfile
        character*30 filename
        character*2 cday
        data z,sx /0.,42./
!- - - - - - - - - -1234567890 - - - - - - - - - - - - - - - - - -
        filename='xxjun88.fin'
        t1='Geochemical and Environmental Research Group'
        t2='Texas A&M University'
        t3='Ten South Graham Road'
        t4='College Station, Texas 77840'
        t5='Telephone: 409 690 0095'
        t6='NORDA Continuous Underway Data'
        t7=' '
        t8='Department of Oceanography'
        j=str$trim(t6,t6,len)
        type '('' enter day of plot ##> '',$)'
        accept '(a)',cday
        t7=cday//' June 1988'
        t6=t6(1:len+1)//t7
        type *,t6
        type *,t7
        k=0
        filename(1:2)= cday
        open(9,name=filename,status='old',iostat=ios)
        type *, 'iost t =',ios,'     '//filename
        if(ios.ne.0) stop
                DO WHILE(.TRUE.)
                        READ(9,'(A)',END=50) IN
                        k=k+1
                        j=str$trim(in,in,ilen)
                        if(mod(k,100).eq.1) type '(''+.'',$)'
                        j=str$translate(in,in,' ',':')
```

```
d                       if(k.lt.10) then
d                               type *,'$1'//in(1:150)
d                               if(ilen.gt.150) type *,'$2'//in(151:ilen)
d                       endif
                        read(in,*,iostat=ios) iyr,imo,iday,ihr,imin,isec,
     *   time(k),flat(k),flon(k),td1,td2,hdg(k),speed(k),ref,
     *   flite1(k),flite2(k),flite3(k),flite4(k),temp(k),salin(k),
     *   ptrans(k),fluor(k),up1(k),up2(k),up3(k),d4,d5,d7,down1(k),depth(k)

d                       type *,iyr,imo,iday,ihr,imin,isec,
d    *   time(k),flat(k),flon(k),td1,td2,hdg(k),speed(k),ref,
d    *   flite1(k),flite2(k),flite3(k),flite4(k),temp(k),salin(k),
d    *   ptrans(k),fluor(k),up1(k),up2(k),up3(k),d4,d5,d7,down1(k),depth(k)

d                       if(k.gt.250) goto 60

                enddo
50              continue
60      continue
!
        pfile = 'ttplotxxZ.iop'
        pfile(7:8)=cday
        IF(LASER) THEN
                pfile(9:9)='L'
        ELSE
                pfile(9:9)='P'
        ENDIF
        type *,'starting plot '//pfile
                xpaper=41.50
                ypaper=32.5
        call iopen(20,pfile)
        IF(     LASER)call set_42 (z,sx,z,sx,  z,sx,z,sx,1)
        IF(.NOT.LASER)call set_60 (z,sx,z,sx,  z,sx,z,sx,1)
        n=k
        do i=1,n
                time(i)=time(i)/3600.
        enddo
        ix1 = time(1)
        ix2 = time(n) + 1
        x1=ix1
        x2=ix2
        type *,' Date to be plotted from ',ix1,' to ', ix2,' hours '
        call draw_box(z,z,xpaper,ypaper)
        call nlgpwrchg(.2)
        y=1.35
        is=8
        call pwritxx(1.,y,t1,is,0,-1)
        y=y-.2
        call pwritxx(1.,y,t2,is,0,-1)
        y=y-.2
        call pwritxx(1.,y,t8,is,0,-1)
        y=y-.2
        call pwritxx(1.,y,t3,is,0,-1)
        y=y-.2
        call pwritxx(1.,y,t4,is,0,-1)
        y=y-.2
        call pwritxx(1.,y,t5,is,0,-1)

        call draw_box(z,z,xpaper,1.6)

        call pwritxx(21.,.8,t6,30,0,0)
        xp=2.
        yp1=xp+1.5
        call plotavec(xp,yp1,time,flat,n,'latitude')
```

```
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,flon,n,'longitude')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,hdg,n,'heading')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,speed,n,'speed')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,flitel,n,'441nm(log)')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,flite2,n,'488(linear)')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,flite3,n,'pyrol-bulb')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,flite4,n,'pyro2-hemi')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,upl,n,'465nm upwelling')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,up2,n,'507nm upwelling')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,up3,n,'532nm upwelling')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,downl,n,'488nm downwelling')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,temp,n,'temperature')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,salin,n,'salinity')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,fluor,n,'fluoresence')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,ptrans,n,'% transmission')
xp=xp+1.6
ypl=xp+1.5
call plotavec(xp,ypl,time,depth,n,'depth')
!---------------------------------------------
do i=ixl,ix2
        ii=i*100
        xx=i
        write(itime,'(i4.4)') ii
        call pwritxx(  xx,  ypl+.15,itime,36,0,0)
enddo
call frame
stop
end

subroutine plotavec(yp,ypt,x,y,n,title)
common /paper/ xpaper,ypaper,LASER
LOGiCAL LASER ! true if ln03 -- false if hp7585b
common /xrange/ x1,x2
character *(*) title
```

```
        real*4 x(n),y(n)
        character*10 ranget,rangeb
        CHARACTER*60 STRING
!-----
        isi=36
        isi1=36
        call minmax(y,n,fmin,fmax)
        write(ranget,'(f9.2)') fmax
        write(rangeb,'(f9.2)') fmin
        STRING=TITLE
        deltay=fmax-fmin
        deltax=x2-x1
        yuin =deltay/( ypt-yp  )
        xuin =deltax/(xpaper-2.)
        plin = .2*yuin
        x2in = 2.*xuin
        x11  = x1+.15*xuin
        x21  = x2-.15*xuin
        type *,STRING
        IF (LASER) then
                call set_42(1.,xpaper-1.,yp,ypt,x1,x2,fmin,fmax,1)
                isi1=36
        elseIF (.NOT.LASER) THEN
                call set_60(1.,xpaper-1.,yp,ypt,x1,x2,fmin,fmax,1)
                isi1=12
        endif
        call draw_box(x1, fmin, x2, fmax)
        call pwritxx(x11,   fmin+plin  , string , isi1,0,-1)
        call pwritxx(x21,   fmin+plin  , rangeb , isi1,0, 1)
        call pwritxx(x21,   fmax-plin  , ranget , isi1,0, 1)
        call curve(x,y,n)
        return
        end
!
        subroutine curve(x,y,n)
        parameter (hiatus = 20./3600.)
        real*4 x(n),y(n)
        dx=0.
        do i=1,n
                if(i.ne.1) dx = x(i) - x(i-1)
                xx=x(i)
                yy=y(i)
                if(i.eq.1 .or. dx.gt.hiatus) then
                        call frstpt(xx,yy)
                else
                        call vector(xx,yy)
                endif
        enddo
        return
        end
!
        subroutine minmax(y,n,ymin,ymax)
        real*4 y(n)
        ymin=1.e30
        ymax=-1.e30
        do i=1,n
                if(y(i).gt. ymax) ymax=y(i)
                if(y(i).lt. ymin) ymin=y(i)
        enddo
        return
        end
!
```

```
C***********************************************************************
C
C PROGRAM       CONTOUR
C
C PURPOSE       1) PROGRAM TO CONTOUR PANAMA CITY TUPS/TESS DATA
C
C AUTHOR        NORMAN GUINASSO
C
C DATE          NOV. 88
C
C REVISION       DEC. 88
C
C
C*************************************************************************
C
      parameter (nx=80,ny=80)
      parameter (n1=6000)
      parameter (n2=n1*13)
      parameter (n3=31*n1)
      parameter (n4=14)
      parameter (ires=25)
      parameter (ires2=ires**2)

      EQUIVALENCE(WK(1),WK1(1))
      EQUIVALENCE(WK(1),WK2(1,1))
      EQUIVALENCE(ADATA(1,1),DEPTH(1))
      EQUIVALENCE(ADATA(1,2),TEMPER(1))
      EQUIVALENCE(ADATA(1,3),SALIN(1))
      EQUIVALENCE(ADATA(1,4),PTRANS(1))
      EQUIVALENCE(ADATA(1,5),FLUOR(1))
      EQUIVALENCE(ADATA(1,6),L465NM(1))
      EQUIVALENCE(ADATA(1,7),L488NM(1))
      EQUIVALENCE(ADATA(1,8 ),L507NM(1))
      EQUIVALENCE(ADATA(1,9 ),L532NM(1))
      EQUIVALENCE(ADATA(1,10 ),TESS441(1))
      EQUIVALENCE(ADATA(1,11 ),TESS488(1))
      EQUIVALENCE(ADATA(1,12 ),TESSPYR1(1))
      EQUIVALENCE(ADATA(1,13 ),TESSPYR2(1))
      EQUIVALENCE(ADATA(1,14 ),SECMID(1))

      COMMON /CONRE1/ IOFFP,SPVAL
      COMMON /CONRE4/ SIZEL    ,SIZEM     ,SIZEP    ,NREP,
     1               NCRT      ,ILAB      ,NULBLL   ,IOFFD ,
     2               EXT       ,IOFFM     ,ISOLID   ,NLA   ,
     3               NLM       ,XLT       ,YBT      ,SIDE
      common /fopen_name/ fname
      character*60 fname
      common /con_grid/ xmin,xmax,ymin,ymax,nnx,nny
      logical larea(nx,ny)

      REAL*4 ADATA(N1,N4)
      REAL*4 FLAT(n1),FLON(n1),DEPTH(n1)
      real*4 temper(n1),salin(n1),ptrans(n1),fluor(n1)
      real*4 L465NM(n1),L488NM(N1),L507NM(N1),L532NM(N1)
      REAL*4 TESS441(N1),TESS488(N1),TESSPYR1(N1),TESSPYR2(N1)
      real*4 array(3,n1),SECMID(N1)
      real*4 wk1(20000),wk2(nx,ny)
      real*4 wk(n2),iwk(n3),SCarr(ires2)
      real*4 area(nx,ny)

      logical aver

      character*12 thedate /'XX June 1988'/
      character*30 title(14)
```

67

```
        CHARACTER*10 FMT
        character*140 in
        character*8 ctime
!=========================================
!       conrec common block
        xlt= .11                ! xoffset
        side=.78                ! length of square
        nrep=3
!======================================
        nnx=nx
        nny=ny
        IOFFP=1
        SPVAL=99999.
!--
        title(1)='DEPTH'
        TITLE(2)='TEMPERATURE'
        title(3)='SALINITY'
        TITLE(4)='PERCENT TRANSMISSION'
        TITLE(5)='FLUORESCENCE'
        TITLE(6)='TUPS 465NM'
        TITLE(7)='TUPS 488NM'
        TITLE(8)='TUPS 507NM'
        TITLE(9)='TUPS 532NM'
        TITLE(10)='TESS 441NM'
        TITLE(11)='TESS 488NM'
        TITLE(12)='TESS PYROMETER 1'
        TITLE(13)='TESS PYROMETER 2'
        TITLE(14)='SECONDS'
        aver = .false.
        xmin =  1000.
        ymin =  1000
        ymax = -1000.
        xmax = -1000.
        CALL FOPENREAD(9)
        thedate(1:2)=fname(4:5)
        type *, ' file date =',thedate
        type '('' how many plots ( max 13) ?  '',$)'
        accept *,nplots
        I=0
        DO WHILE (.TRUE.)
                M=I+1
                read(9,'(a)',iostat=jos) in
                if(jos.ne.0) goto 10
                call pulloff(in,ctime,len)
                READ(in,*,IOSTAT=IOS)
     *              flat(m),flon(m),depth(m),
     *              temper(M),salin(M),ptrans(M),fluor(M),
     *              l465nm(m),l488nm(m),l507nm(m),l532nm(m),
     *              tess441(m),tess488(m),tesspyr1(m),tesspyr2(m)

                if(ios.eq.0) then
                        i=i+1
                else
                        type *, 'bad line'
                endif
        enddo
10      continue
        k=0
        npts=i
        nret=0
        type *, npts,n1,n4,' CALLING SAMEPTS '
        call samepts(flat,flon,ADATA,npts,N1,N4,Nret)
        npts=nret
        type *,npts,'  points left after samepts'
```

```
      do i=1,npts ! fill lat lon arrays
              array(1,i)=flat(i)
              array(2,i)=flon(i)
              call xyminmaxs(flon(i),flat(i),xmin,xmax,ymin,ymax)
      enddo
      type *,' lon min max ',xmin,xmax
      type *,' lat min max ',ymin,ymax
      call mapmin(xmin,xmax,ymin,ymax)
      type *,' lon min max ',xmin,xmax
      type *,' lat min max ',ymin,ymax
      ioptn=1         ! 1= mask on 0= mask off
      ireach=5
      call mask_init (.false.,larea)

      call mask_conrec(flat,flon,npts,ireach,ioptn,larea)

d     call mask_show(larea)

      call pcity_land(0,larea)

d     call mask_show(larea)

      call lib$init_timer()

      DO KN=1,nplots
!             set up array for weaver:
              do i=1,NPTS
                      array(3,i)=adata(i,kn)
              enddo

      dx=xmax-xmin
      dy=ymax-ymin
      dxy=dx

! weaver parameters
      dist= .075*dxy ! measure of distance to fill ( dist must be <.5*dxy )
      ilr     =0 ! wrap left right
      ibt     =0 ! wrap bottom top
      iweav   =1 ! 0=weave lr first; 1=weave bt first
      idec    =2 ! decimal places
      ifine   =1 ! number of times through emphasize
      centr   =1.! weight of center
      ichek   =0 ! ı  urned error parameter
      wxmin = xmin
      wxmax = xmax
      wymin = ymin
      wymax = ymax
      nxw=nx
      nyw=ny

      type *, ' dist, dx, xy = ' ,dist,dx,dy
      type *, 'nx,ny ',nx,ny
      type *  , ' min max ',wxmin,wxmax,wymin,wymax

      call weaver(array,npts,area,wk2,nxw,nyw,
     *        wxmin,wxmax,wymin,wymax,dist,
     *        ilr,ibt,iweav,idec,ifine,centr,ichek)

      type *, 'after weaver ichek = ',ichek

      call mask_apply(area,larea)

      call conrec(area,nx,nx,ny,0.,0.,0.,0,-1,0)
```

```
        j=str$trim(title(kn),title(kn),len)
        type *,title(kn)(1:len)
        z0=0.
        z1 = xlt
        z2 = xlt+ side
        z3 = .05 +side
        zw=1.
        call set (z1,z2,.05,z3,xmin,xmax,ymin,ymax,1)
        call dashd('$"$"$"$"$"$"',12,5,1)
        call curvedh(flon,flat,npts)
d       call curve(flon,flat,npts)
        call pcity_land(1,larea)
        call set (z1,z2,z1,z2, z1,z2,z1,z2,1)
        call pwritxx(.14,.78,title(kn),12,0,-1)
        call pwritxx(.14,.75,thedate,12,0,-1)
        iz=10
        call map_write_latlon(.5, .05-.02 ,iz,0,0,ymin,'lat')
        call map_write_latlon(.5,  z3+.02 ,iz,0,0,ymax,'lat')
        call map_write_latlon(z1-.02, .5  ,iz,90,0,xmin,'lon')
        call map_write_latlon(z2+.02, .5  ,iz,90,0,xmax,'lon')
        call frame
        call lib$show_timer()
        ENDDO
        stop
        end
!==================================================================
        subroutine curvedh(x,y,n)
        real*4 x(n),y(n)
        logical penup
        penup=.true.
        thresh = .5/60. ! approx .5 NM
        call frstd(x(1),y(1))
        do i=2,n
                dx = x(i)-x(i-1)
                dy = y(i)-y(i-1)
                dx =dx*cosd(y(i))
                di = sqrt (dx**2 + dy**2)
                if (di.gt. thresh) then
                        type *,'FRSTD n= ',i
                        call lastd
                        call frstd(x(i),y(i))
                        penup = .false.
                else
                        call vectd(x(i),y(i))
                        penup = .true.
                endif
        enddo
        call lastd
        return
        end
! ============================================
        subroutine mask_apply(area,larea)
!       applys conrec mask to weaver output file
!       guinasso, circa 1988
        common /conrel/ ioffp,spval
        common /con_grid/ xmin,xmax,ymin,ymax,nx,ny
        logical larea(nx,ny)
        real*4  area(nx,ny)
        character*50 line
!
        type *, ' mask_apply ',nx,ny
        do i=1,NX
        do j=1,NY
                if(.not.larea(i,j)) area(i,j)=spval
```

```
      enddo
      enddo
      return
      end
!
! ==================================================================
      subroutine mask_init(linit,larea)
      common /con_grid/ xmin,xmax,ymin,ymax,nx,ny
      logical larea(nx,ny)
      logical linit
      do j=1,ny
      do i=1,nx
              larea(i,j)=linit
      enddo
      enddo
      return
      end
!
      subroutine mask_show(larea)
      common /con_grid/ xmin,xmax,ymin,ymax,nx,ny
      logical larea(nx,ny)
      z1 = .05
      z2 = .95
      dx = (xmax-xmin)/float(nx-1)
      dy = (ymax-ymin)/float(ny-1)
      call set(z1,z2,z1,z2,xmin,xmax,ymin,ymax,1)
      do j=1,ny
              ynode=ymin+(j-1)*dy
      do i=1,nx
              xnode=xmin+(i-1)*dx
              if(larea(i,j)) call ticm(xnode,ynode,dx/15.)
      enddo
      enddo
      call frame
      end
!
      subroutine mask_conrec(flat,flon,npts,ireach,ioptn,larea)
      common /con_grid/ xmin,xmax,ymin,ymax,nx,ny
      logical larea(nx,ny)
! flat flon defines a track
! ioptn= 1 turns on grid pts near track
! ioptn= 0 turns off grid points near track
! xmin,xmax,nx ymin,ymax,ny defines a grid nx by ny
! lflag(i,j) is true if point i,j is within dist1 of any point on track
! this defines a a mask that can be applied to a data grid passed to conrec
! guinasso, circa 1988
!
      real*4 flat(npts),flon(npts)
      logical mask1,mask2
      dist(x,y)= (x**2 + y**2)
!
      if(ioptn.eq.1) then
              mask1= .true.
              inc=   1
      else
              mask1= .false.
              inc = -1
      endif
      itot=nx*ny
      tot=itot
      dx=(xmax-xmin)/float(nx-1)
      dy=(ymax-ymin)/float(ny-1)
      dis   = min(dx,dy)
      dist1 = (ireach*dis)**2
```

```
      TYPE *,'ENTERING MASK_CONREC with ioptn = ',ioptn,inc
      type '('' dx,dy dist1='',3f12.4)',   dx,dy,dist1
      type *,' '
      ion=0
      do j=1,ny
              ynode=ymin+(j-1)*dy
      do i=1,nx
              xnode=xmin+(i-1)*dx
              if(mask1.eq.larea(i,j)) then
              else
                 do k=1,npts
                      dely  = flat(k)-ynode
                      delx  = flon(k)-xnode
                      dist2 = dist(delx,dely)
                      if(dist2 .lt. dist1) then
                              larea(i,j) = mask1
                              ion = ion + inc
                              goto 5
                      else
                      endif
                 enddo
              endif
5     continue
      fion=100.*ion/tot
      if(mod(i,ny).eq.0 .and. mod(j,10).eq.0) type 109,j,fion
      enddo
      enddo
      type *, ' Mask conrec-i- cells changed, total cells= ',ion,itot
      return
109   format('+ j, percent switched = ',i5,f6.1,'   ')
      end
!##############################################################################
      subroutine samepts(flat,flon,ADATA,n,nd1,nd2,nret)
! removes data with duplicate locations
! N = NUMBER OF LINES
! MD = DIMENSION OF ADATA
! ND = NUMBER OF DATA VARIABLES
! guinasso, circa 1988
      real*4 flat(n),flon(n),ADATA(nd1,nd2)
      logical skip(6000)
      ireject=0
      do i=2,n
              do j=1,i-1
                      if(flat(i).eq.flat(j) .and. flon(i).eq.flon(j)) then
                              ireject = ireject+1
                              skip(i) = .true.
                              goto 10
                      else
                              skip(i)=.false.
                      endif
              enddo
10    enddo
      k=0
      do i=1,n
              IF(SKIP(I)) THEN
              else
                      flat(k+1)=flat(i)
                      flon(k+1)=flon(i)
                      DO KD=1,ND2
                              ADATA(k+1,KD)=ADATA(i,KD)
                      ENDDO
                      k=k+1
                      nret=k
              endif
```

72

```
      enddo
      type *,' total, returned, rejected =',n,nret,ireject
      return
      end
!
      subroutine pcity_land(iflag,larea)
      common /con_grid/ xmin,xmax,ymin,ymax,nx,ny
      logical larea(nx,ny)
      real*4 flat(500),flon(500)
!
      open(19,name='pcitymap.f10',status='old',iostat=kos)

      if(kos.ne.0) stop 'pcitymap.f10 not found'
      ipold=0         ! last line #
      npts=0
      nlines=0        ! lines plotted
      do while (.true.)
              read(19,*,iostat=kos) num,ip,x,y,alAt,alon
              alon=-alon
              if(ip.ne.ipold .or. kos.eq.-1) then
                      if(nlines.ne.0) then
                              if(iflag.eq.1) then
                                call tcurve(flon,flat,npts)
                              else
                                call mask_conrec(flat,flon,npts,1,0,larea)
!
!     subroutine mask_conrec(flat,flon,npts,ireach,ioptn,larea)
                              endif
                              if(kos.eq.-1) then
                                      close (19)
                                      return
                              endif
                      endif
                      nlines=nlines+1
                      npts=1
                      flat(1)=alat
                      flon(1)=alon
                      ipold=ip
                      type *, ' pcity_land-i-nlines = ',nlines
              else
                      npts=npts+1
                      flat(npts)=alat
                      flon(npts)=alon
              endif
      enddo
      end

      subroutine mapmin(flon1,flon2,flat1,flat2)
      if(flon1.gt.0) stop 'mapmin'
      flon1=-flon1
      flon2=-flon2
      iflat1 = flat1*60.
      iflat2 = flat2*60.
      iflon1 = flon1*60.
      iflon2 = flon2*60.
      flat1=float(iflat1  )/60.
      flat2=float(iflat2+1)/60.
      flon1=-float(iflon1+1)/60.
      flon2=-float(iflon2  )/60.
      return
      end
      subroutine tcurve(x,y,n)
      external between
      common /con_grid/ xmin,xmax,ymin,ymax,nx,ny
```

```
      real*4 x(n),y(n)
      LOGICAL between
      logical penup
      penup  = .true.
      do i=1,n
              if(     between(xmin,xmax, x(i)) .and.
     *                between(ymin,ymax, y(i))
     *            ) then
                      if(penup) then
                              call frstpt ( x(i),y(i) )
                              penup = .false.
                      else
                              call vector ( x(i),y(i) )
                      endif
              else
                      penup =.true.
              endif
      enddo
      return
      end
```

 74

```
C*******************************************************************
C
C PROGRAM       M1
C
C PURPOSE       1) sets up map for land boundary plotting
C
C
C AUTHOR        NORMAN GUINASSO
C
C DATE          circa 1985
C
C REVISION      NOV. 1988
C
C takes calibration data and x,y station data from a *.mca file
C calls map_calib to make a *.cof file from calibration data
C also can call map_make_square to make a *.cof file for a square projection
C also looks for a *.flt auxillary file for data input as lat lon
C then calculates x y or lat long for each data point
C and writes all to a *.f10 file
C all files take their * name from the specified input file
C*********************************************************************
C
        common /mapname/ infile
        common /mapoffsets/ xoff,yoff,fac
        character*70 title
        character ans
! calibration data:
        real*4  x(110),y(110)           ! x,y coordinates in inches
        real*4 flat(110),flon(110)      ! lat and long in decimal degrees
! data points:
        integer*4 ident(900)
        real*4 xx(900),yy(900),xz,yz    ! x,y for data points
        real*4 xl(900),yl(900)          ! long, lat fro data points
        logical square                  ! if square plot set up a simple map
        logical finnmark /.FALSE./      ! special handling for finnmark
        logical digit_with_calib
        logical to_xy           /.true./
        logical to_latlon       /.false./

        character*30 infile,outfile,auxfile
        character*60 auxformat
        logical rot_clkwise
        logical flt_file

! ================================================================
! calibrated  or square
! x,y points or flt file
!
        fac=1.
        j=lib$init_timer()
        type *, 'Program M1 version 1.1'

        square=.true.
        type '(''  calibrated or square? (c/s) -->'',$)'
        accept '(a)', ans
        if(ans.eq.'c' .or. ans.eq.'C') square=.false.
        if(square) then
                type   *,' scale? '
                accept *,sqscale
        endif

101     format(' Enter input file name -> ',$)
        type 101
        accept 103,infile
```

```
        call chgext(infile,outfile,'f10')
        open(10,name=outfile,err=991,status='NEW',
     1          carriagecontrol='LIST')

!-----------------------------------------------------------------
! if .flt file is found, then assume lat lon is there
! first record contains format
! with each of the following records containing:
! station lat_deg lat_min flat_secs lon_deg lon_min flon_secs
!
        call chgext(infile,auxfile,'flt')
        open(11,name=auxfile,status='OLD',err=10)
! found aux file:
                digit_with_calib = .false.
                type *, 'Found auxillary file with lat lon data: ',auxfile
                read(11,'(a)' )         auxformat
                type '(1x,a)',' ',      auxformat
                goto 11
! did not find aux file:
10                      digit_with_calib = .true.
!
11      continue
!-----------------------------------------------------------------
! start:

        flt_file= .not. digit_with_calib

        if(.not.(flt_file.and.square)) then
!               we need to read calibration data
!
        call chgext(infile,infile,'mca')
        OPEN(9,name=infile,err=990,status='old',readonly)
        read(9,100)     n,title
        type 109,       n,title
        write(10,109)   n,title

        if (n.gt.110) then
                type *, ' this will not work, n too big'
                stop
        endif

! read in calibration data
138     format(' Rotate clockwise? (y/n) --> ',$)
        type 138
        accept '(a)', ans
        rot_clkwise = .false.
        if(ans.eq.'y' .or. ans.eq.'Y') rot_clkwise=.true.
        do i=1,n
                read(9,*,end=900,err=901) Lat,Long,x(i),y(i)
                if(rot_clkwise)  then
                        xtemp =  x(i)
                        x(i) =  y(i)
                        y(i) = -xtemp
                endif
!               TYPE *,'DENIS MODIFIED ME'
                flat(i) = ghexij(lat)
                flon(i) = ghexij(long)
                TYPE 102,flat(i),flon(i),x(i),y(i)
                write(10,102) flat(i),flon(i),x(i),y(i)
        enddo
        endif
```

```
        if (square) then
                call map_make_square(sqscale,1)  ! (scale, 1= write file)
        else
                call map_calib(flat,flon,x,y,n)
        endif



! ------------------------------------------------
                if(finnmark) then
                        nskip=21
                        do k=1,nskip
                        read(9,103) title
                        enddo
                endif
! ------------------------------------------------
        i=1             ! next point to read
        npoints=0       ! points read

        if(digit_with_calib) then

                read (9 ,103)   title
                write(10,106)   title
!       read station locations from digitizer file as x,y
                do while (.true.)
                        read(9,*,end=50,err=50) ident(i),xx(i),yy(i)
                        if(rot_clkwise)  then
                                xtemp =  xx(i)
                                xx(i) =  yy(i)
                                yy(i) = -xtemp
                        endif
                        type 107,ident(i),xx(i),yy(i)
                        if(finnmark) ident(i)=ident(i)+2000
                        npoints =npoints+1
                        xt=xx(i)
                        yt=yy(i)
                        call map_xform(ft,fg,xt,yt,to_latlon)   ! to lat long
                        xl(i)=fg
                        yl(i)=ft
                        write(10,108) i,ident(i),xx(i),yy(i),yl(i),xl(i)
                        i       =       i+1
                enddo

        else
!               read station locations from auxillary file as lat long
        do while (.true.)
                read(11,auxformat,end=50,err=44) ident(i),
     1           latdeg,latmin,secslat,londeg,lonmin,secslon
                npoints =npoints+1

d               type '(2i4,f6.1,2i4,f6.1)',
d    1           latdeg,latmin,secslat,londeg,lonmin,secslon

! function ghexijf converts degrees minutes and seconds to floating degrees
! degrees and minutes are integers, seconds are floating point

                fg=ghexijf(londeg,lonmin,secslon)
                ft=ghexijf(latdeg,latmin,secslat)
        type *,ft,fg

d               type '(i4,2f10.3)', ident(i),ft,fg,ident(i),xz,yz
                call map_xform(ft,fg,xz,yz,to_xy)       ! to x,y
                xl(i)=fg ! long
                yl(i)=ft ! lat
                xx(i)=xz
```

/7

```
              yy(i)=yz
              write(10,108) i,ident(i),xx(i),yy(i),yl(i),xl(i)
              i       =      i+1
              goto 45
44      type *, ' error while reading on unit 11 ',auxfile
45      enddo
        endif! (digit_with_calib)


50      continue

        type *, 'number of points = ',npoints
        j=lib$show_timer()
        stop 'normal ending'

900     stop 'program m1-f-unexpected end of data'
901     stop 'program m1-f-error reading calibration data'
990     stop 'program m1-f-error opening input file unit 9'
991     stop 'program m1-f-error opening output file'

100     format (i3,a)                    ! read format
102     format(1x,2f10.3,2f10.4)
103     format(a)
106     format(1x,a)
108     format(1x,2I7,4f12.5)
107     format(1x,i4,2f8.2)
109     format(1x,i3,' --->',a)
! square with calibration data and point data
! square without calibration data and with flt file
! calibration data and x,y data
! calibration data and lat long data in flt file
        end
```

```
/*****************************************************************/
/*                                                               */
/* PROGRAM      READ.SAS                                         */
/*                                                               */
/* PURPOSE      1)  sas program to consolidate .fin files        */
/*                                                               */
/* AUTHOR       NORMAN GUINASSO                                  */
/*                                                               */
/* DATE         NOV. 88                                          */
/*                                                               */
/* REVISION     DEC. 88                                          */
/*                                                               */
/*****************************************************************/
        FILENAME PCITY1 '[DENIS.PCITY]19JUN88.FIN';
        LIBNAME NORDA '[DENIS.PCITY]';
        DATA temp1;
        INFILE PCITY1;
        INPUT   YEAR MONTH DAY TIME $ SECS_MID
                LAT LON T_DELAY1 T_DELAY2
                HEADING SPEED VREF TESS441 TES448
                TESSPYR1 TESSPYR2 TEMPER SALIN
                PTRANS FLUOR L465NM L507NM L532NM
                TRANSVLT FL_SIG_V FL_SCL_V L488NM DEPTH;
        data temp2;
        FILENAME PCITY2 '[DENIS.PCITY]20JUN88.FIN';
        INFILE PCITY2;
        INPUT   YEAR MONTH DAY TIME $ SECS_MID
                LAT LON T_DELAY1 T_DELAY2
                HEADING SPEED VREF TESS441 TES448
                TESSPYR1 TESSPYR2 TEMPER SALIN
                PTRANS FLUOR L465NM L507NM L532NM
                TRANSVLT FL_SIG_V FL_SCL_V L488NM DEPTH;
        data temp3;
        FILENAME PCITY3 '[DENIS.PCITY]21JUN88.FIN';
        INFILE PCITY3;
        INPUT   YEAR MONTH DAY TIME $ SECS_MID
                LAT LON T_DELAY1 T_DELAY2
                HEADING SPEED VREF TESS441 TES448
                TESSPYR1 TESSPYR2 TEMPER SALIN
                PTRANS FLUOR L465NM L507NM L532NM
                TRANSVLT FL_SIG_V FL_SCL_V L488NM DEPTH;
        data norda.all;
                set temp1 temp2 temp3;
        PROC MEANS;
        ENDSAS;
```

```
/**********************************************************************/
/*                                                                    */
/* PROGRAM      PUTALL.SAS                                            */
/*                                                                    */
/* PURPOSE      1)  sas program to make smooth data file              */
/*                                                                    */
/*              2)  scans large sas file and outputs                  */
/*                  selective records                                 */
/*                                                                    */
/* AUTHOR       NORMAN GUINASSO                                       */
/*                                                                    */
/* DATE         NOV. 88                                               */
/*                                                                    */
/* REVISION     DEC. 88                                               */
/*                                                                    */
/**********************************************************************/
        FILENAME PCITY '[DENIS.PCITY]all21.nav';
        LIBNAME NORDA '[DENIS.PCITY]';
        DATA TEMP;
                FILE PCITY;
                SET NORDA.all;
                IF DAY= 21 THEN PUT
                    TIME 1-10 LAT 10.6 LON 11.6 DEPTH 6.2
                    @40 TEMPER SALIN PTRANS FLUOR L465NM L488NM L507NM L532NM
                    TESS441 TES448 TESSPYR1 TESSPYR2 SECS_MID;
        ENDSAS;
```

80

```
/*****************************************************************/
/*                                                               */
/* PROGRAM      CORR.SAS                                         */
/*                                                               */
/* PURPOSE      1)  sas program to produce correlation matrix    */
/*                                                               */
/* AUTHOR       NORMAN GUINASSO                                  */
/*                                                               */
/* DATE         DEC. 88                                          */
/*                                                               */
/* REVISION     DEC. 88                                          */
/*                                                               */
/*****************************************************************/
        LIBNAME NORDA '[DENIS.PCITY]';
        data temp;
                set norda.all;
                tess448 = tes448;
                keep tess448 tess441 tesspyrl tesspyr2
                        temper salin ptrans fluor
                        L465NM L507NM L532NM L488NM DEPTH;
        proc corr data=TEMP;
        ENDSAS;
```

```
C*********************************************************************
C
C PROGRAM        READ 350
C
C PURPOSE        1) RT-11 FORTRAN_IV program to read disk to recover files
C
C                2)  modified for NORDA PRO-350 1988
C
C AUTHOR         NORMAN GUINASSO
C
C DATE           1982
C
C REVISION       OCT. 1988
C
C
C**********************************************************************
C

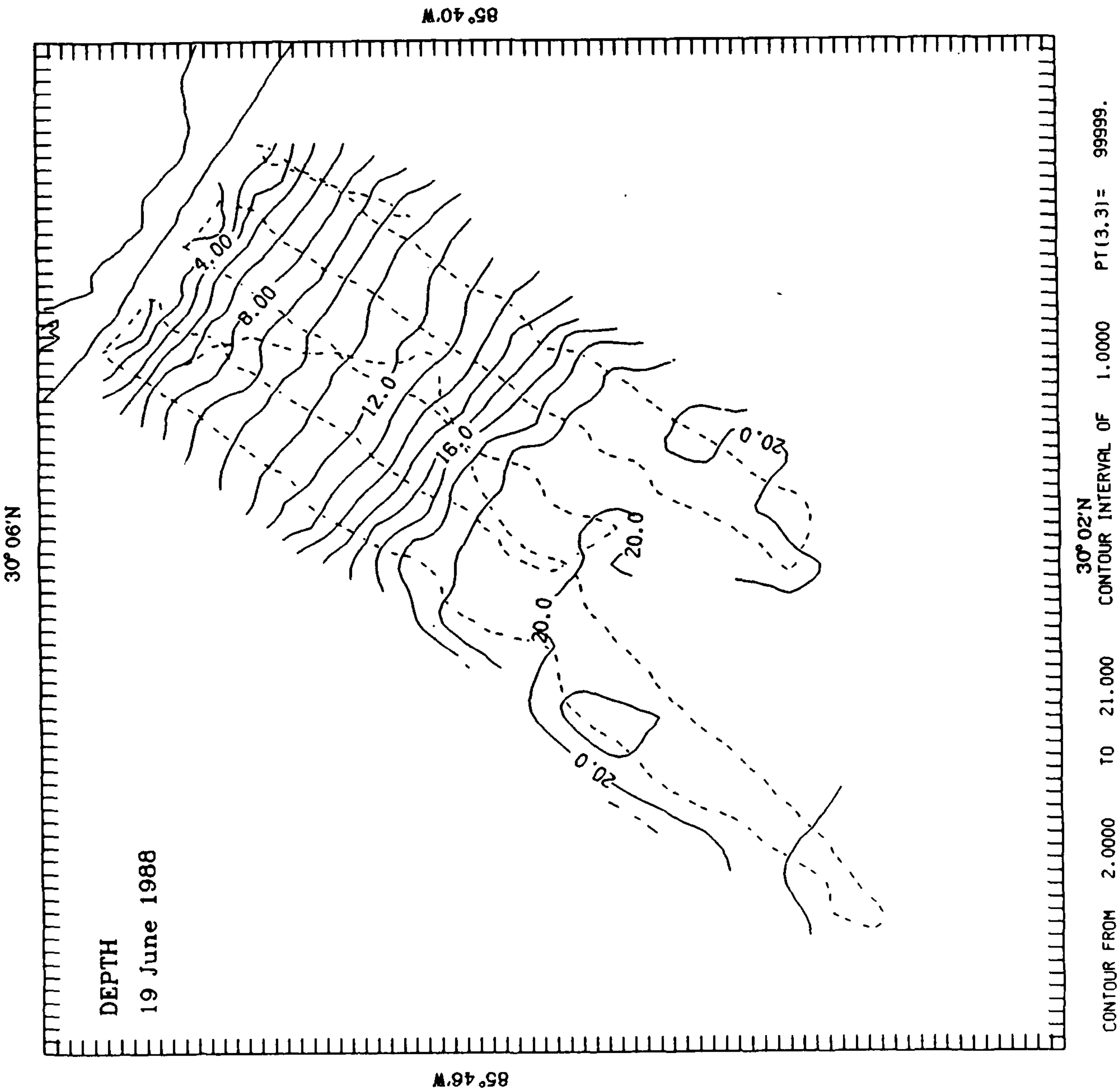
      integer*2 dblk(4)        ! floppy
      integer*2 dblko(4)       ! output file
      byte buff(514)           ! block buffer
      byte bell                ! ring
      byte ans                 ! a character
      logical octal            ! print to screen in octal
      logical ascii            ! print to screen in ascii
      logical wtf              ! write to file
c
      data bell /7/            ! ^G
      data dblk /3RDWO,3R   ,3R   ,3R   /      ! the pro350
      data dblko/3RDZ1,3RREA,3RDXX,3ROUT/      ! du0:readxx.out
c
      buff(513)=0
      buff(514)=0
      type *, ' program to use hardware read to recover files'
      type *, ' from floppy - - - guinasso, circa 1987'
c .
      lb      =       1+istop-istart           ! length of output file
c
c options:
c
      ascii   =       .false. ! write first 75 characters of block ascii
      wtf     =       .false. ! write first 75 characters of block ascii
      type *, ' printout block in Ascii, Octal, or None?'
              accept 101,ans
      if(ans.eq.'a' .or. ans.eq.'A') ascii    =.true.
      if(ans.eq.'o' .or. ans.eq.'O') octal    =.true.
      type *,' write to file? '
              accept 101,ans
      if(ans.eq.'y' .or. ans.eq.'Y') wtf      =.true.
c
c get channels
      ich=igetc()              ! channel for floppy
      ichout=igetc()           ! channel for output file
c
c open disk as file:
      if(ifetch(dblk).lt.0) stop 'bad fetch'  ! fetch floppy handler
      if(lookup(ich,dblk).lt.0) stop 'lookup failed' ! open floppy
c
c     if(.not.wtf) goto 4                      ! writing to file
      if(ienter(ichout,dblko,lb).lt.0)
     %                stop 'enter failed'      ! open output
      type *,' file opened for output'
      iblko=0                                  ! first block is 0
c
```

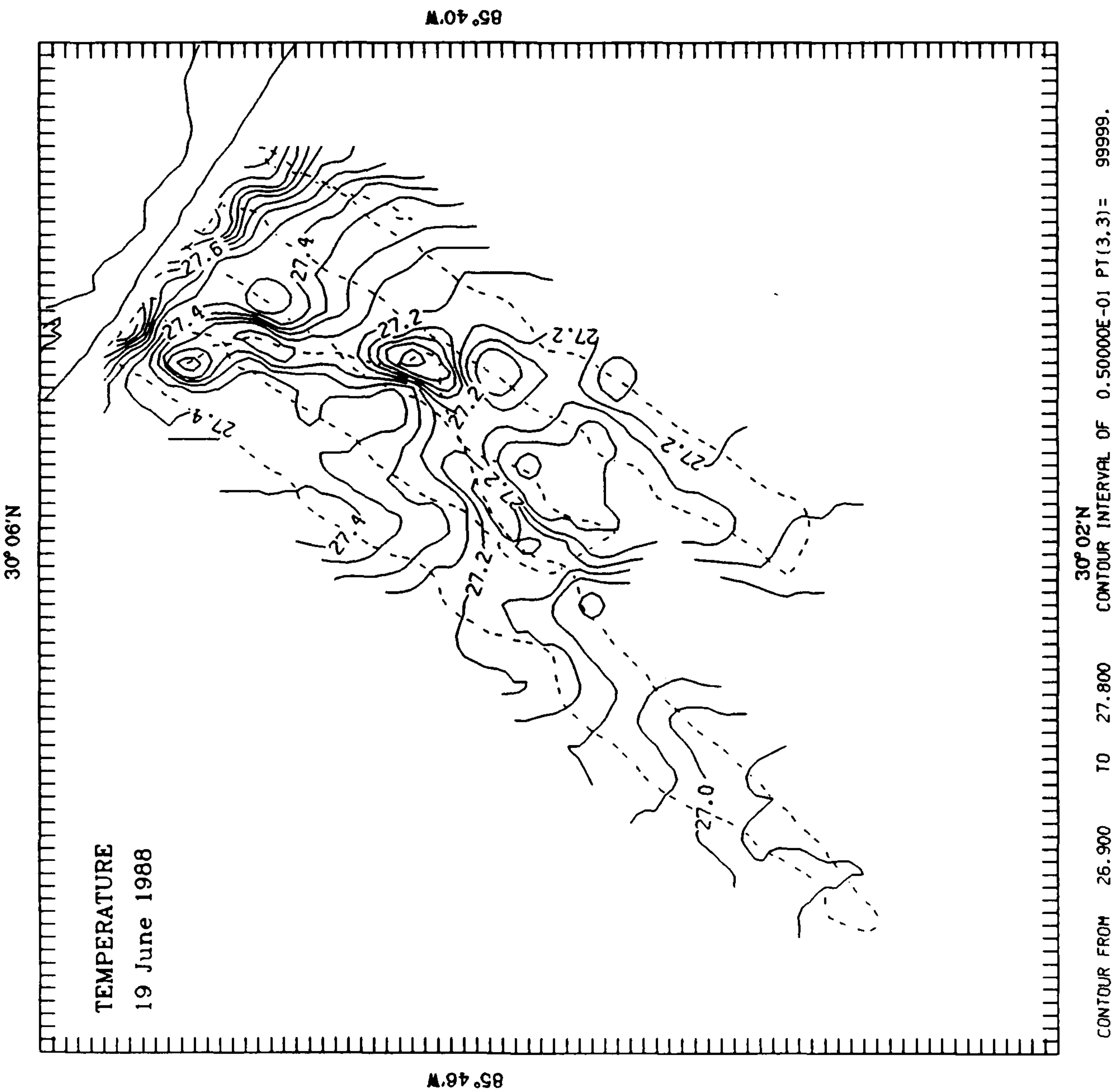
```
        istart=0
        istop=11000
4       iblk=istart
c
        do 10 i=1,10100
                ierr=0
5               continue
                j=ireadw(256,buff,iblk,ich)
                if(j.eq.-1) goto 11     ! end of file
                if(j.eq.-2) goto 8      ! error
                type *, ' BLOCK = ',    iblk
                iblk            =       iblk+1
                jin=index(buff,'20-JUN-88')
                wtf=jin
                if(wtf)         j =     iwritw(256,buff,iblko,ichout)
                if(wtf) iblko   =       iblko+1
                if(octal)       type 100,(buff(k),k=1,75)
                if(ascii)       type 103,(buff(k),k=1,75)
                if(iblk.gt.istop)  goto 20
                goto 10
c
c hard error handling
c
8               type 102 ,bell,iblk
                ierr=ierr+1
                if(ierr.lt.4) goto 5            ! retry 3 times
                stop ' hardware error'
c
10      continue
        goto 20
11      type *,'eof, block=', iblk
20      call iclose(ich)
        call iclose(ichout)
        stop
100     format(20o4)
101     format(a)
102     format(1x,a,' hard error, block=',i4)
103     format(80a1)
        end
```

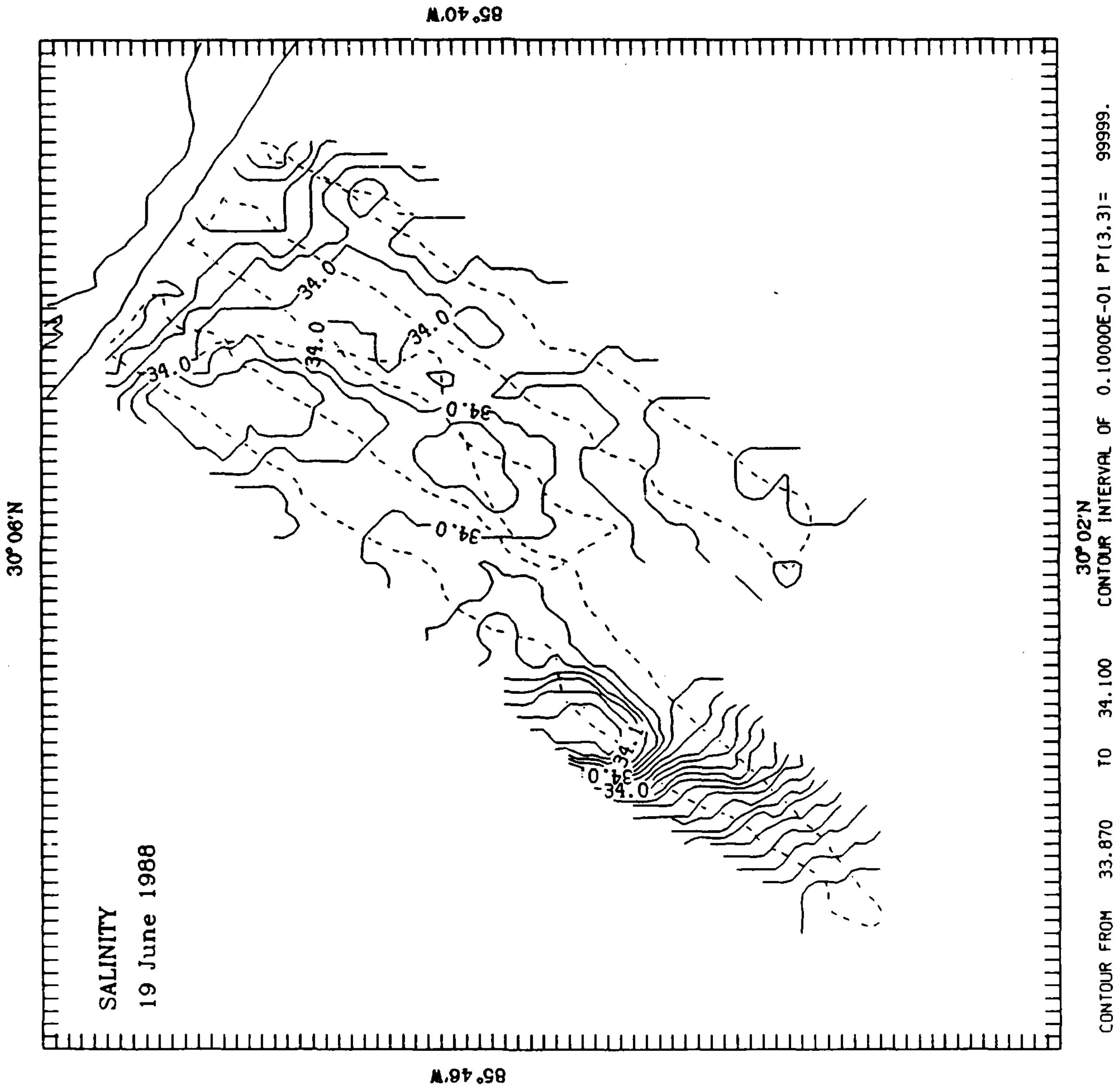
```
/*******************************************************************/
/*                                                                 */
/* PROGRAM      PLOT.SAS                                           */
/*                                                                 */
/* PURPOSE      1)  sas program to plot light data                 */
/*                                                                 */
/* AUTHOR       NORMAN GUINASSO                                    */
/*                                                                 */
/* DATE         DEC. 88                                            */
/*                                                                 */
/* REVISION     DEC. 88                                            */
/*                                                                 */
/*******************************************************************/
/* PLOT LIGHT DATA AND DEPTH*/
       LIBNAME NORDA '[DENIS.PCITY]';
       DATA NORDA.ALLSUB;
               set norda.all;
               tess448 = tes448;
               NORM_UP = L507NM/TESSPYR1;/*NORMALIZED UPWELLING L507*/
               INORM_UP = 1./NORM_UP;
               KEEP
               DAY tess448 tess441 tesspyrl tesspyr2
               temper salin ptrans fluor NORM_UP INORM_UP
               L465NM L507NM L532NM L488NM DEPTH;
       DATA TEMP;
               SET NORDA.ALLSUB;
               IF DAY=19 AND DEPTH<12.;
       PROC PLOT DATA=TEMP;
               PLOT DEPTH*INORM_UP;
               TITLE 'INVERSE NORMALIZED 507NM UPWELLING IRRADIANCE';
               TITLE2 '19 JUNE 1988';
       DATA TEMP;
               SET NORDA.ALLSUB;
               IF DAY=20 AND DEPTH<12.;
       PROC PLOT DATA=TEMP;
               PLOT DEPTH*INORM_UP;
               TITLE 'INVERSE NORMALIZED 507NM UPWELLING IRRADIANCE';
               TITLE2 '20 JUNE 1988';
;
       DATA TEMP;
               SET NORDA.ALLSUB;
               IF DAY=21 AND DEPTH<12.;
       PROC PLOT DATA=TEMP;
               PLOT DEPTH*INORM_UP;
               TITLE 'INVERSE NORMALIZED 507NM UPWELLING IRRADIANCE';
               TITLE2 '21 JUNE 1988';
       ENDSAS;
;
```

APPENDIX B

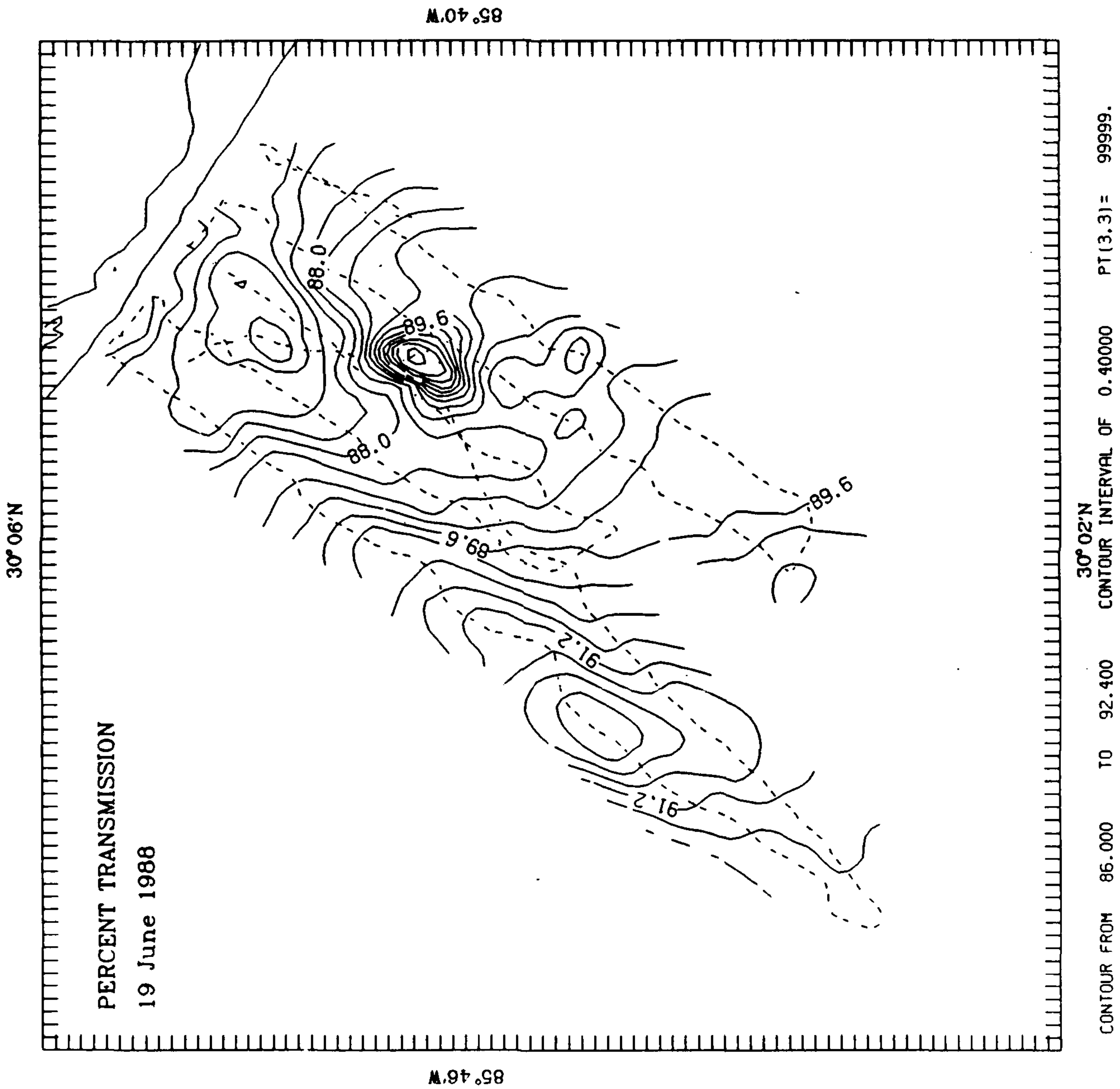
CONTOUR MAPS


DEPTH
19 June 1988
85°40'W
85°46'W
30°06'N
30°02'N
4.00
8.00
12.0
16.0
20.0
20.0
20.0
20.0
CONTOUR FROM 2.0000 TO 21.000 CONTOUR INTERVAL OF 1.0000 PT(3,3)= 99999.

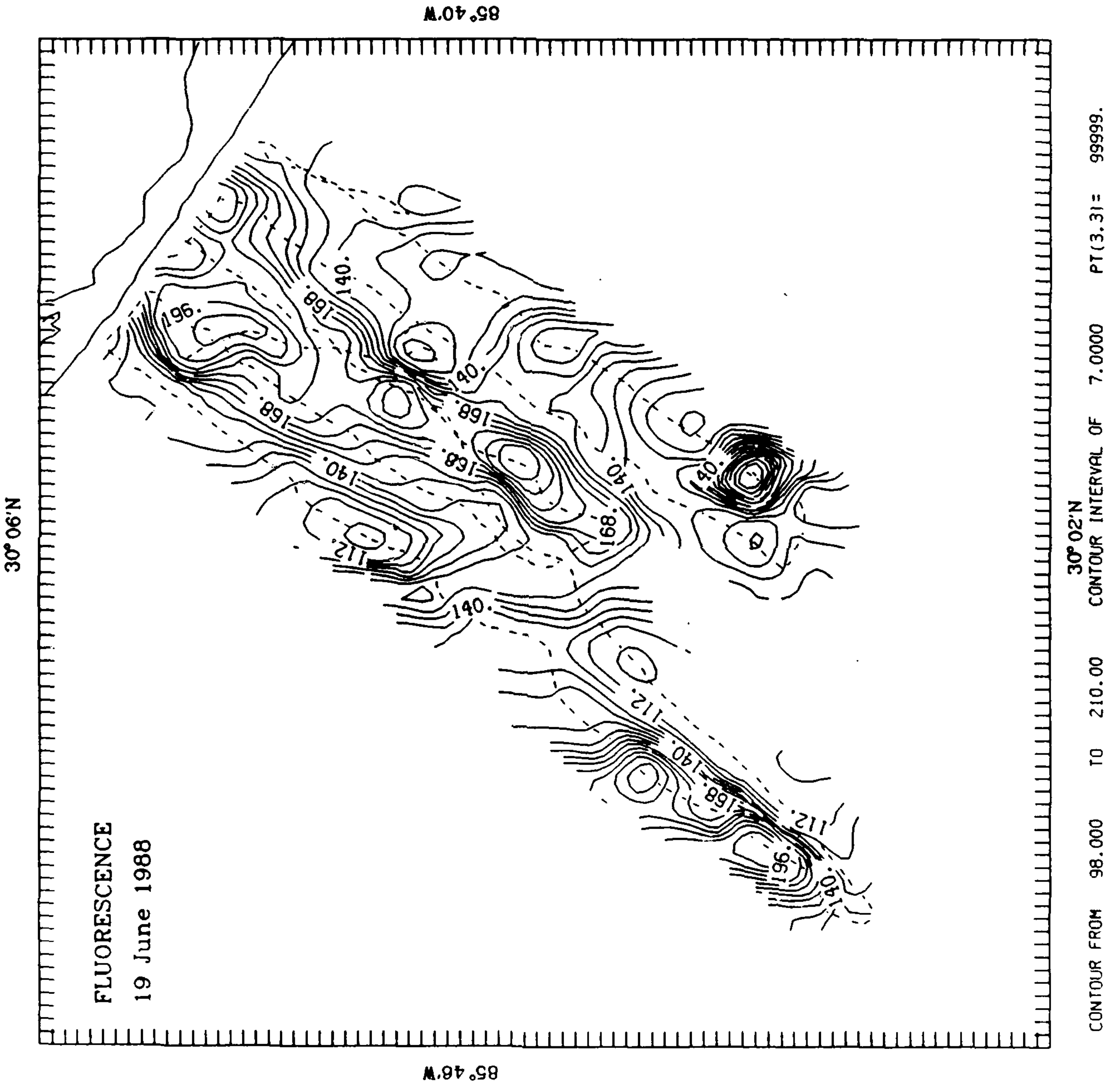

85°40'W
85°46'W
30°06'N
30°02'N
TEMPERATURE
19 June 1988
27.6
27.4
27.2
27.0
CONTOUR FROM 26.900 TO 27.800 CONTOUR INTERVAL OF 0.50000E-01 PT(3,3)= 99999.

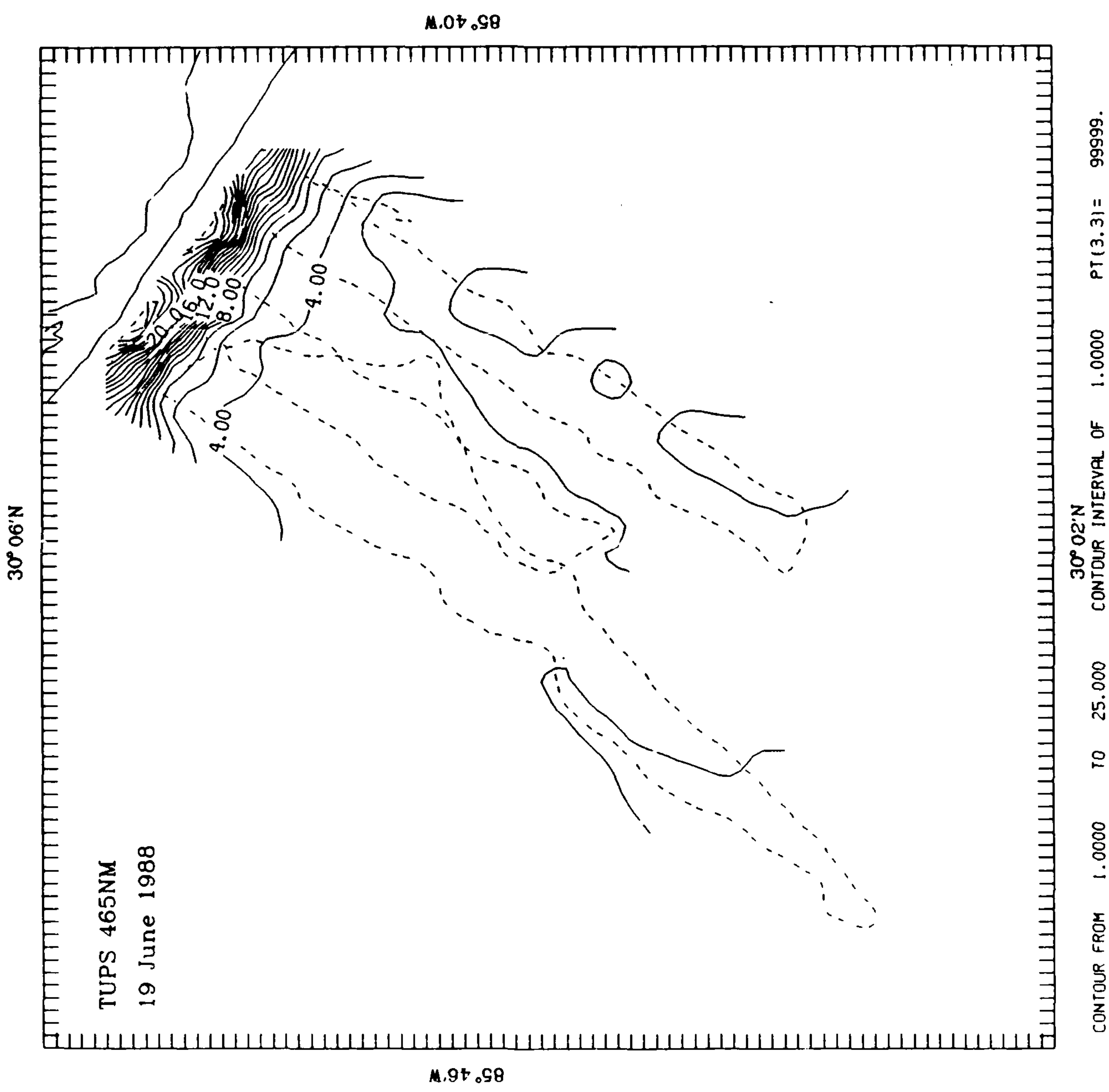


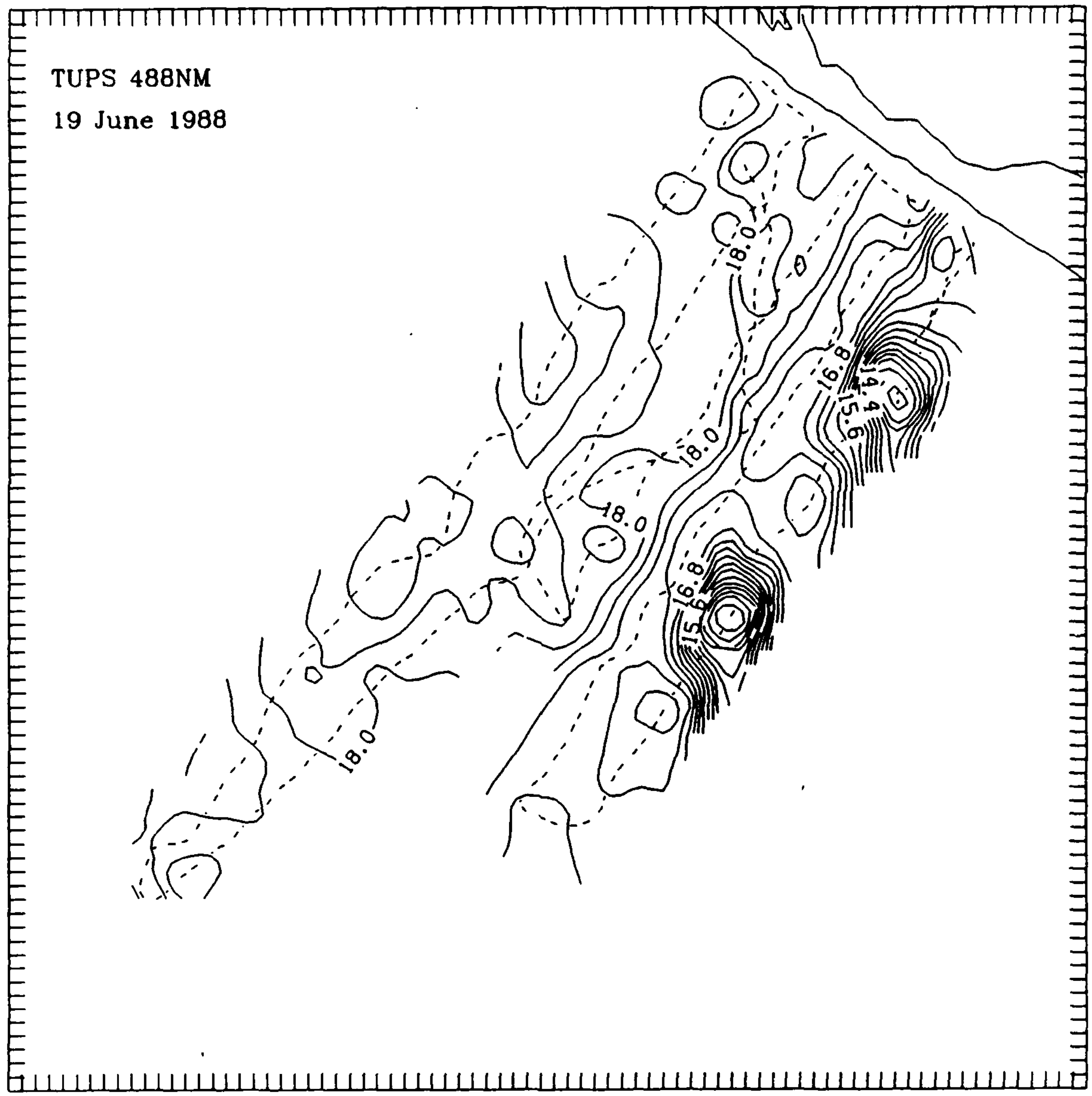
SALINITY
19 June 1988
30°08'N
30°02'N
85°40'W
85°46'W
34.0
CONTOUR FROM 33.870 TO 34.100 CONTOUR INTERVAL OF 0.10000E-01 PT(3,3)= 99999.



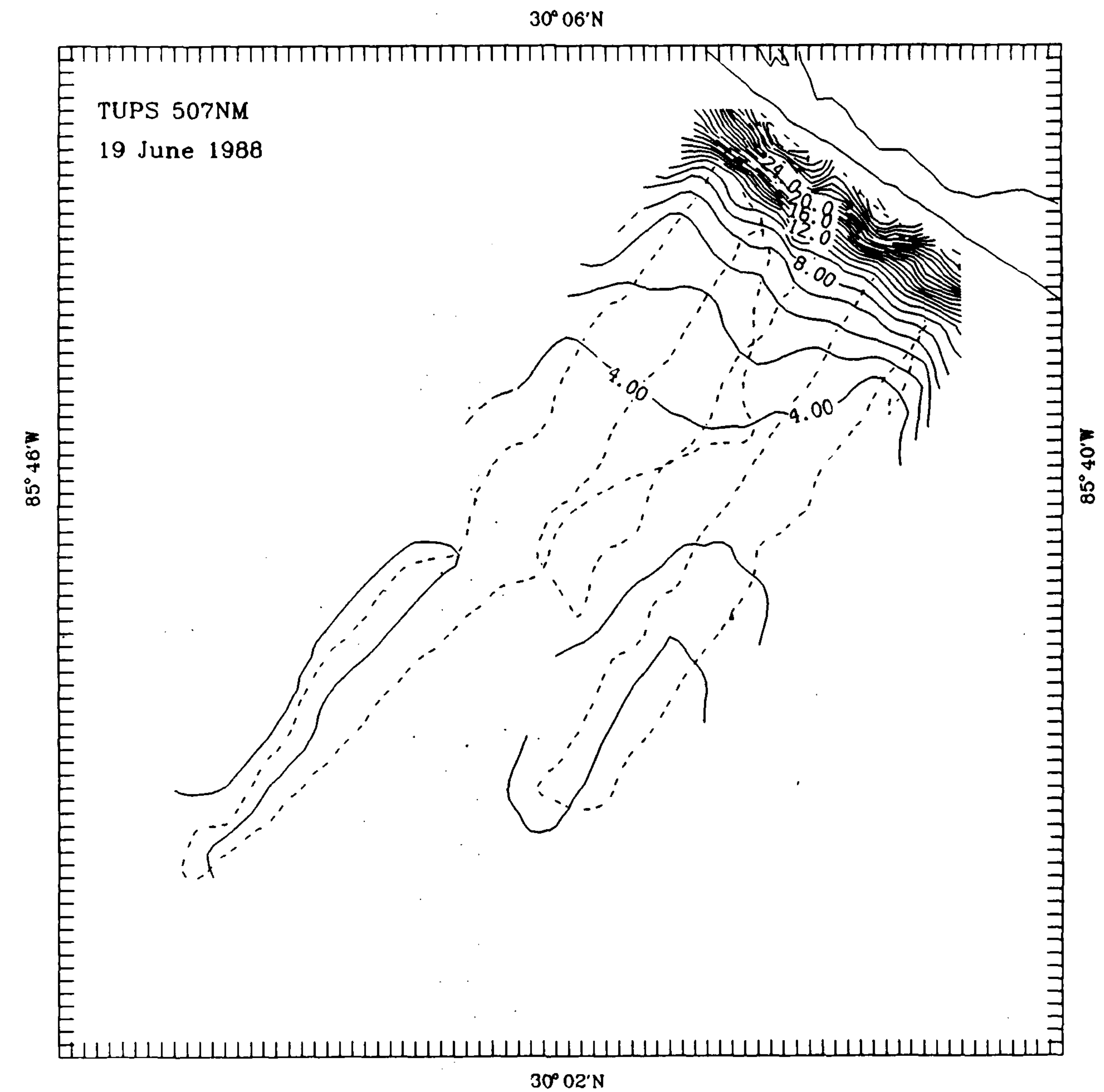
PERCENT TRANSMISSION
19 June 1988
85°40'W
85°46'W
30°06'N
30°02'N
88.0
89.6
91.2
CONTOUR FROM 86.000 TO 92.400 CONTOUR INTERVAL OF 0.40000 PT(3,3)= 99999.


FLUORESCENCE
19 June 1988
30°06'N
30°02'N
85°40'W
85°46'W
112.
140.
168.
196.
CONTOUR FROM 98.000 TO 210.00 CONTOUR INTERVAL OF 7.0000 PT(3,3)= 99999.

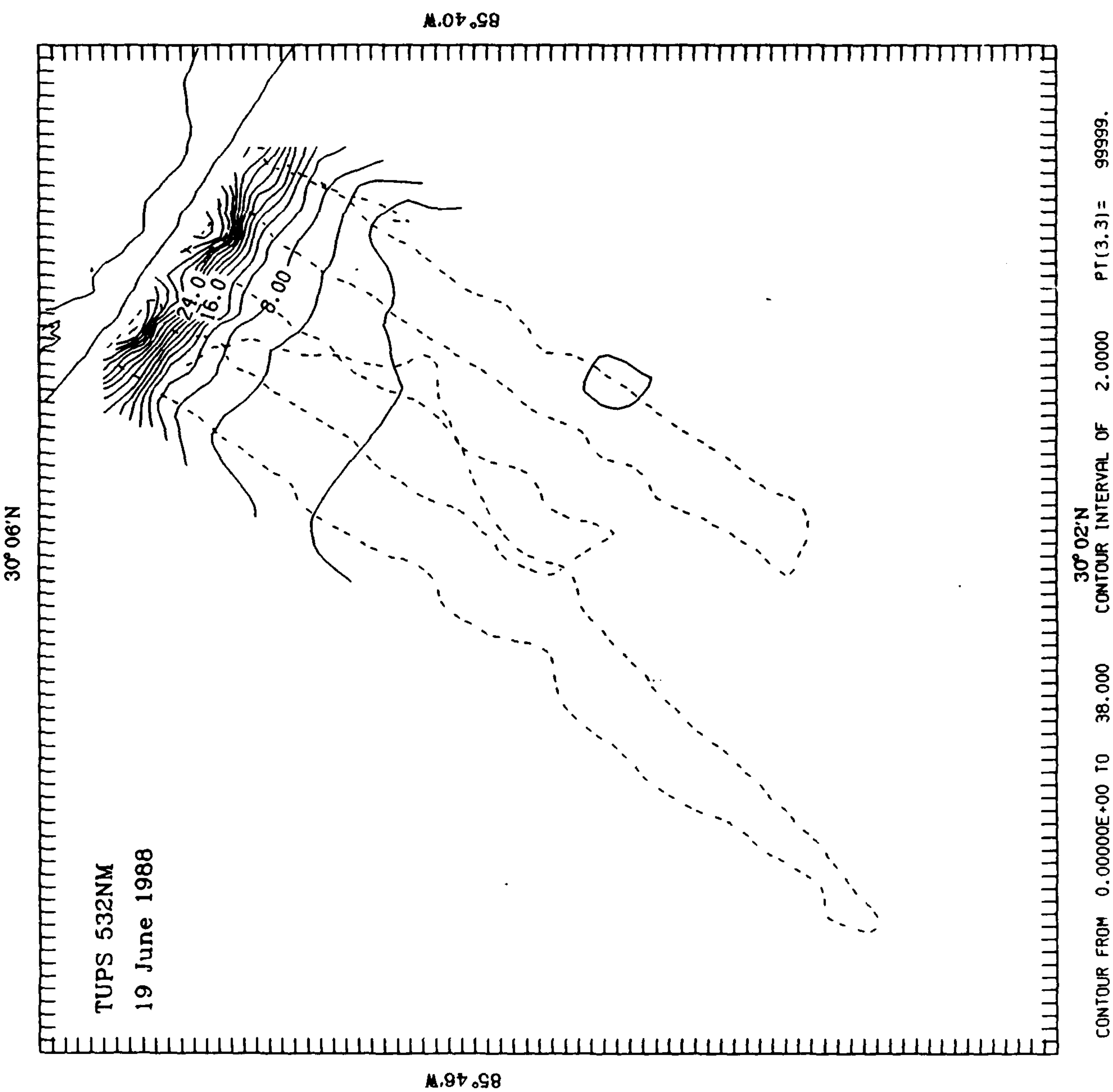

85° 40'W
85° 46'W
30° 06'N
30° 02'N
TUPS 465NM
19 June 1988
20.0
16.0
12.0
8.00
4.00
CONTOUR FROM 1.0000 TO 25.000 CONTOUR INTERVAL OF 1.0000 PT(3,3)= 99999.

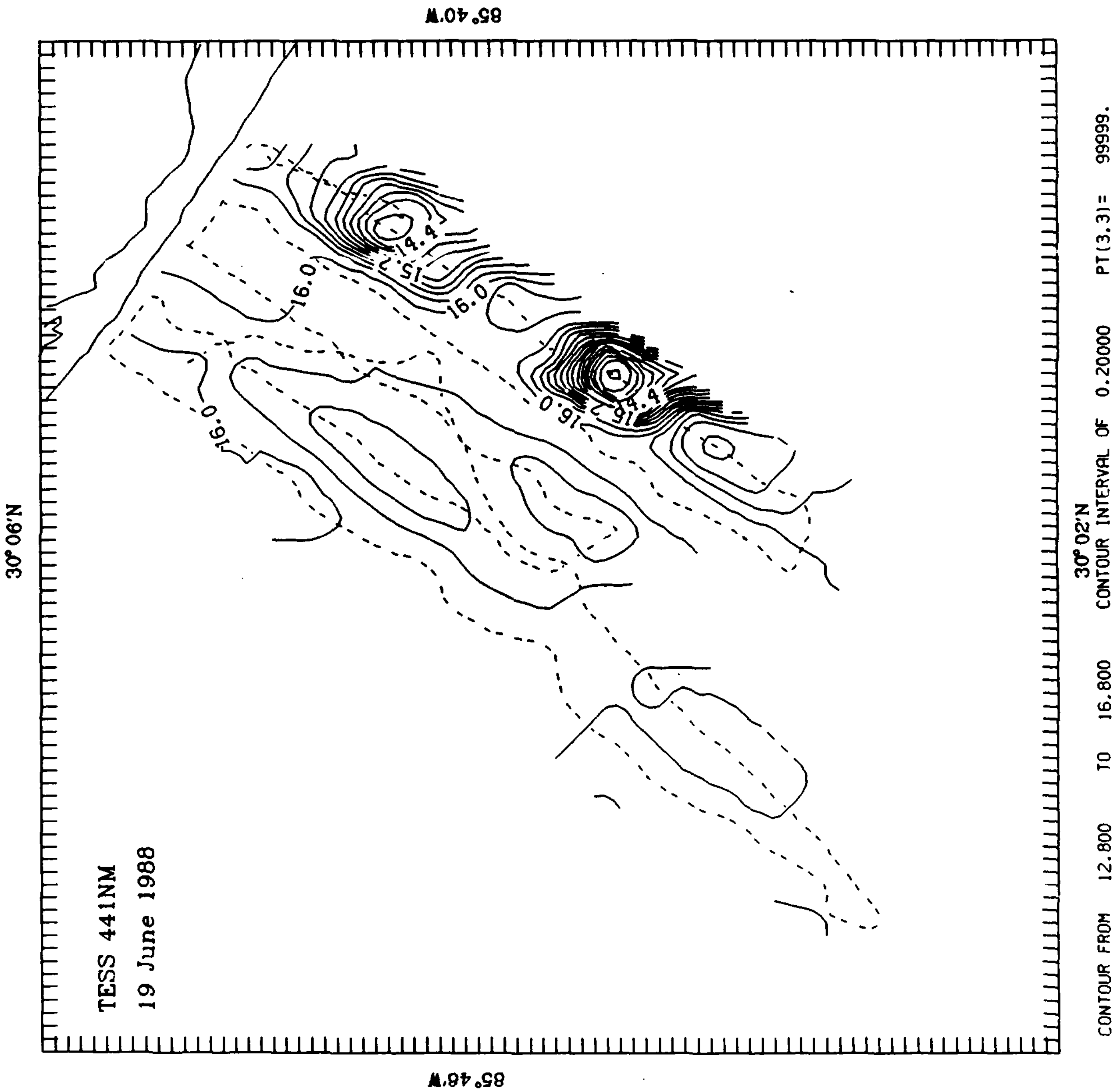


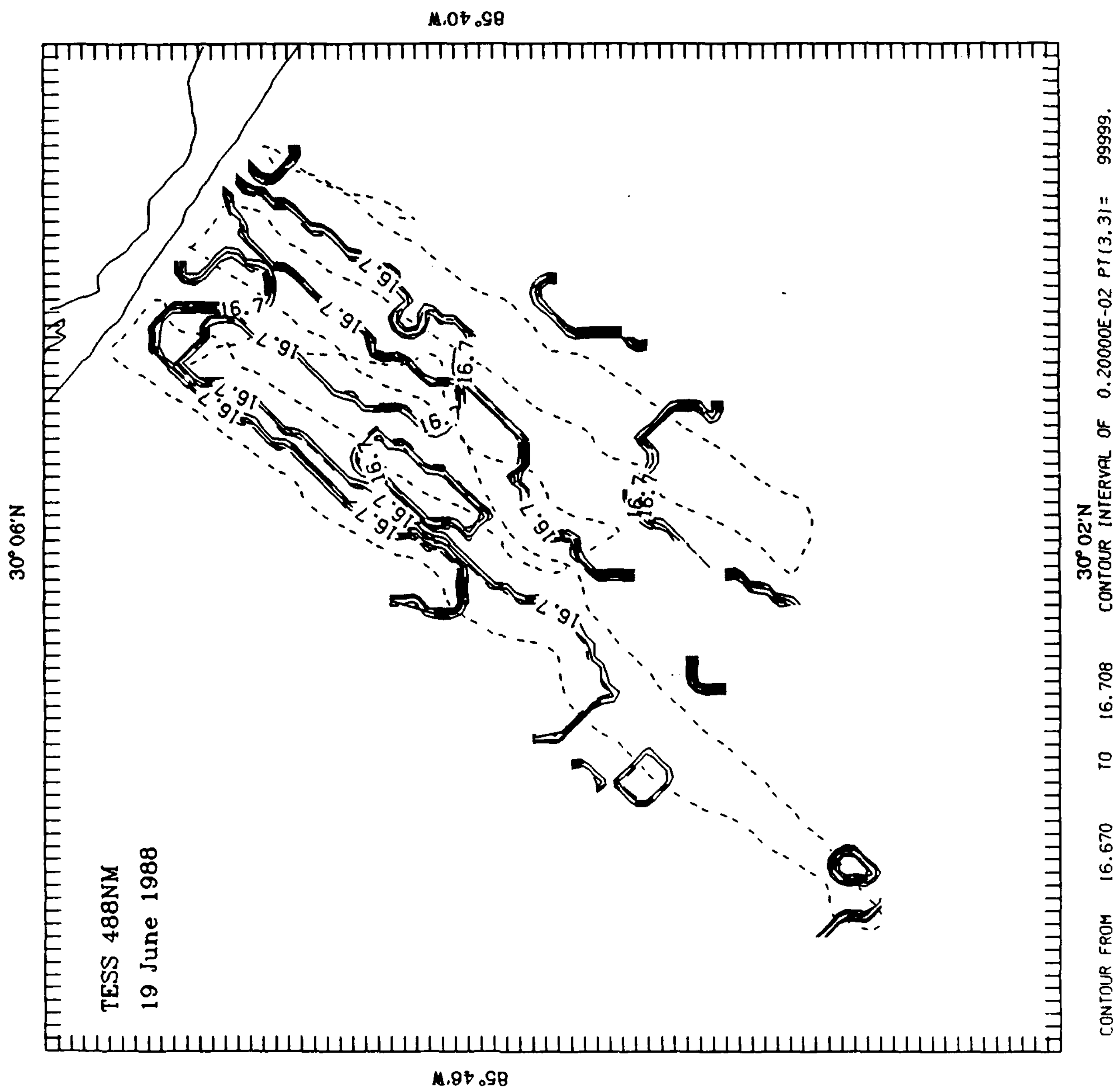
CONTOUR FROM 12.900 TO 18.900 CONTOUR INTERVAL OF 0.30000 PT(3,3)= 99999.



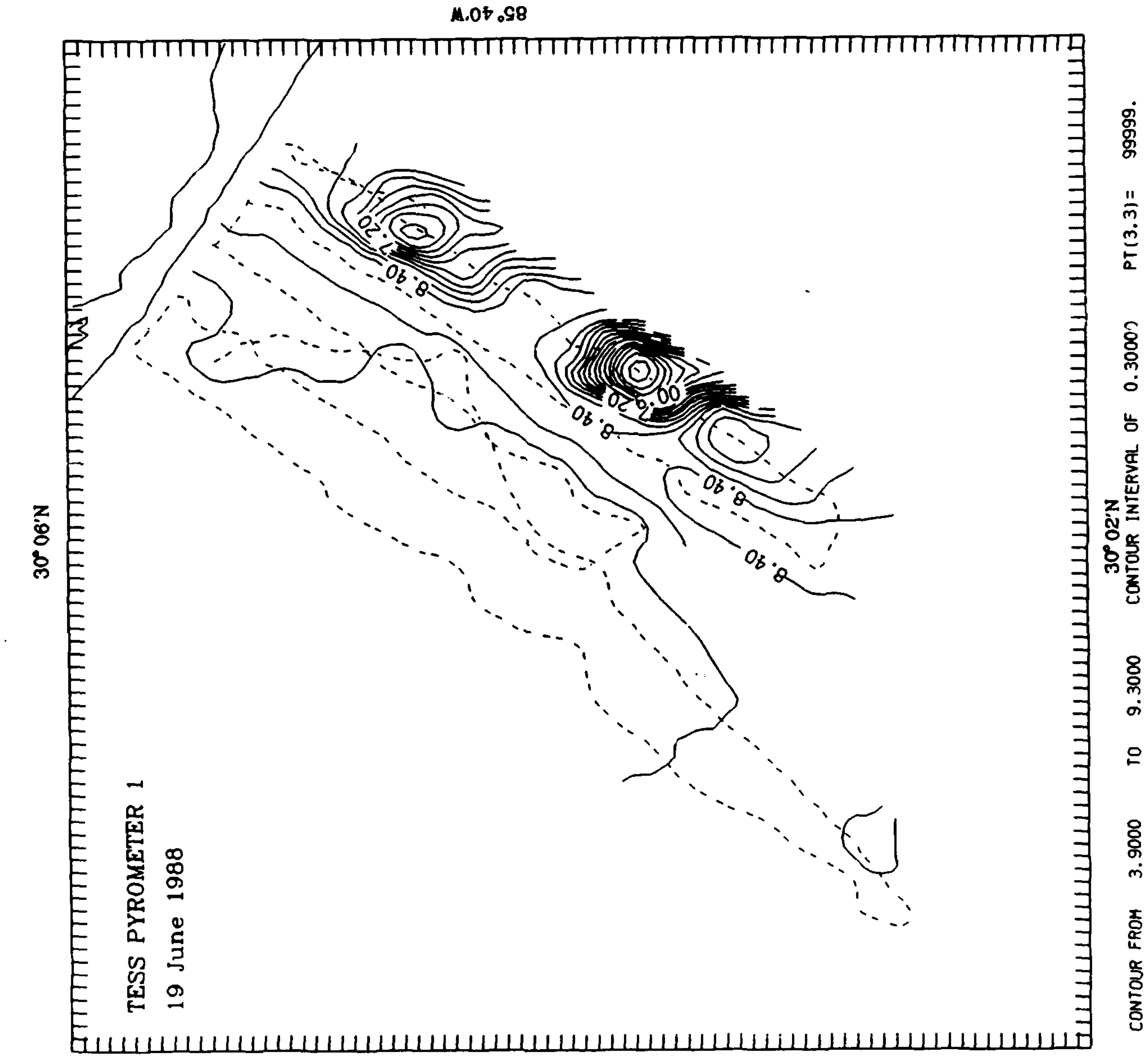
CONTOUR FROM 1.0000 TO 33.000 CONTOUR INTERVAL OF 1.0000 PT(3,3)= 99999.


85°40'W
85°46'W
30°06'N
30°02'N
TUPS 532NM
19 June 1988
24.0
16.0
8.00
CONTOUR FROM 0.00000E+00 TO 38.000 CONTOUR INTERVAL OF 2.0000 PT(3,3)= 99999.

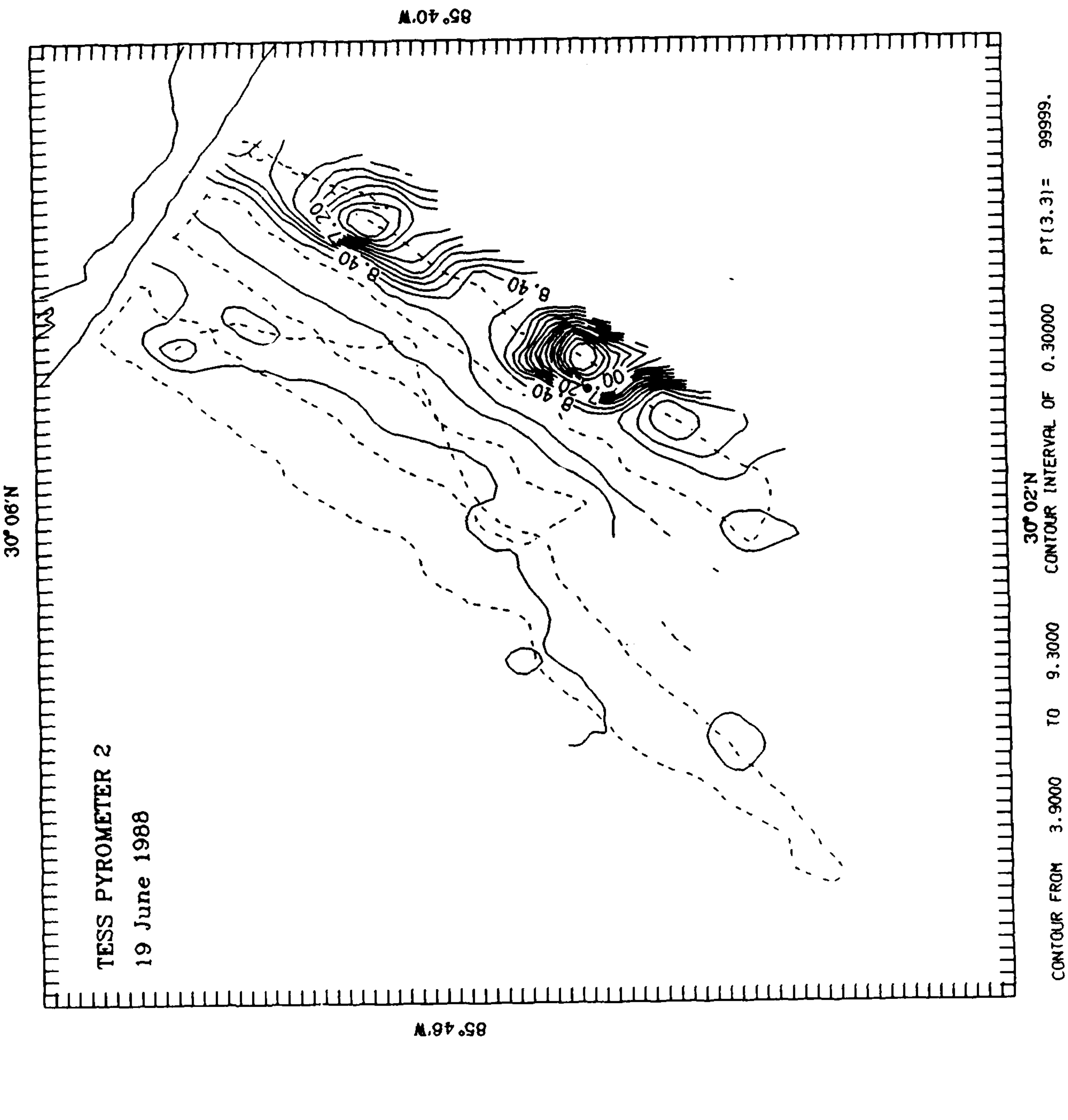

85°40'W
85°48'W
30°06'N
30°02'N
TESS 441NM
19 June 1988
14.4
15.2
16.0
CONTOUR FROM 12.800 TO 16.800 CONTOUR INTERVAL OF 0.20000 PT(3,3)= 99999.

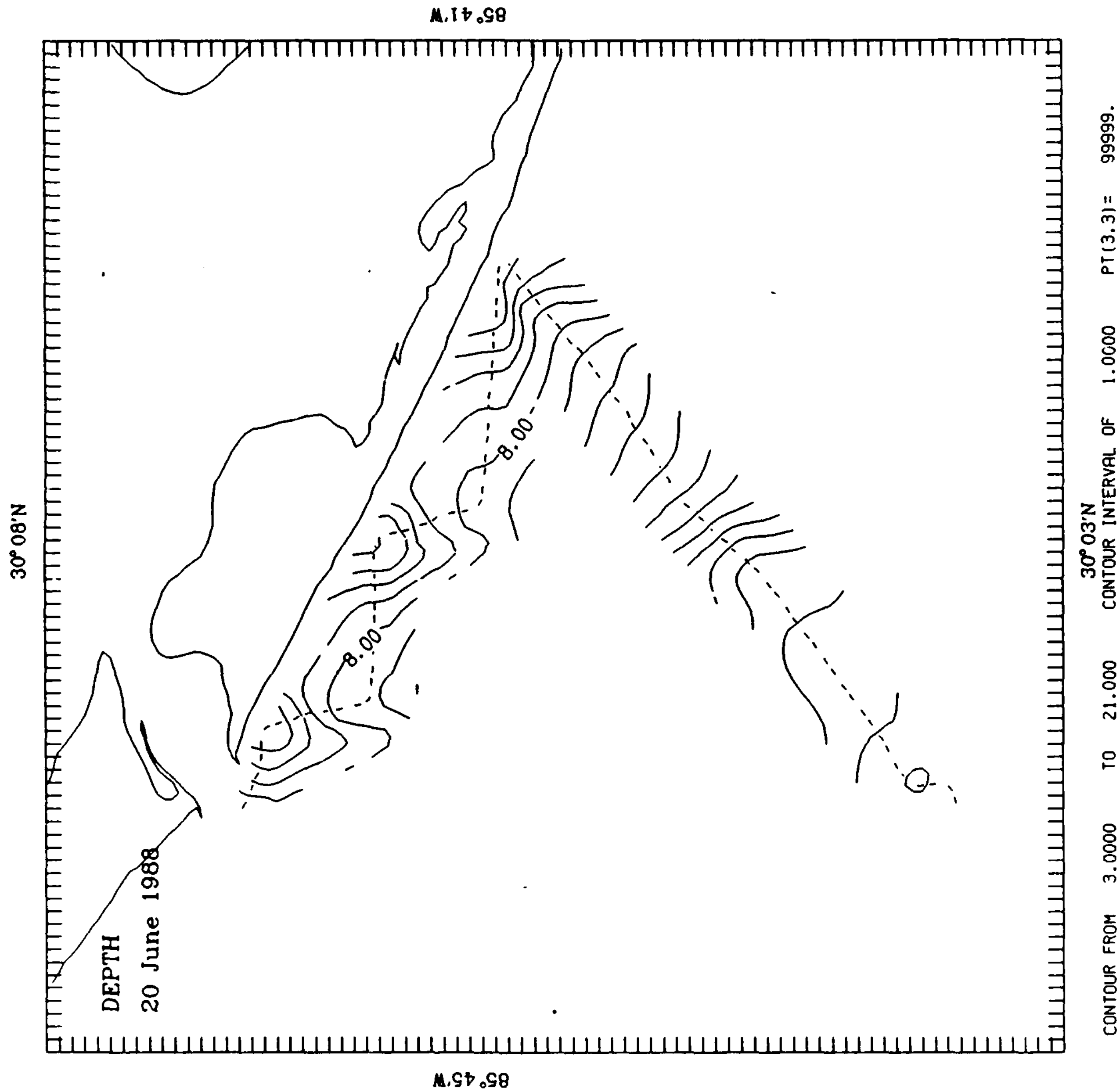


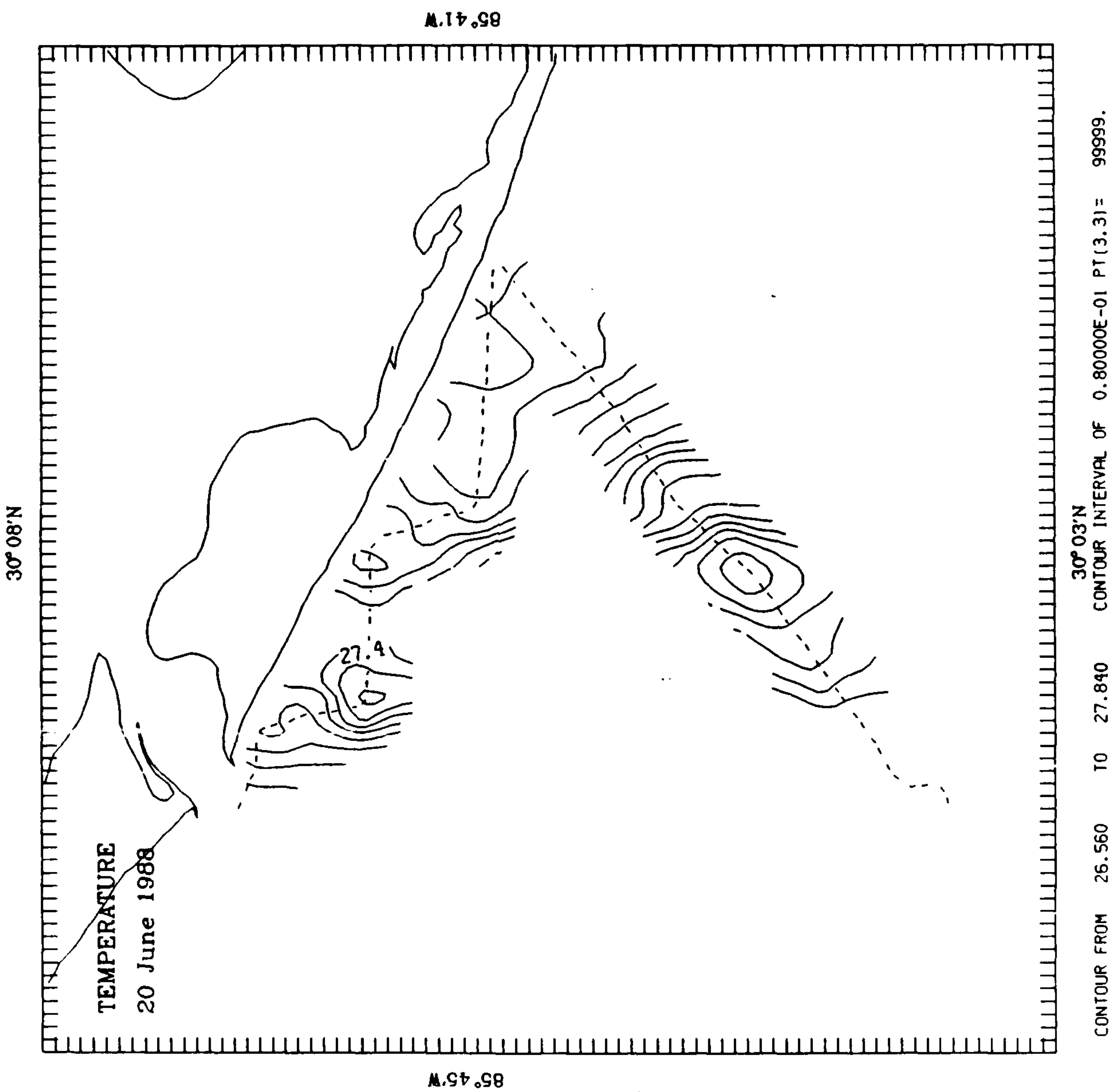
TESS 488NM
19 June 1988
85°40'W
85°48'W
30°06'N
30°02'N
16.7
CONTOUR FROM 16.670 TO 16.708 CONTOUR INTERVAL OF 0.20000E-02 PT(3,3)= 99999.

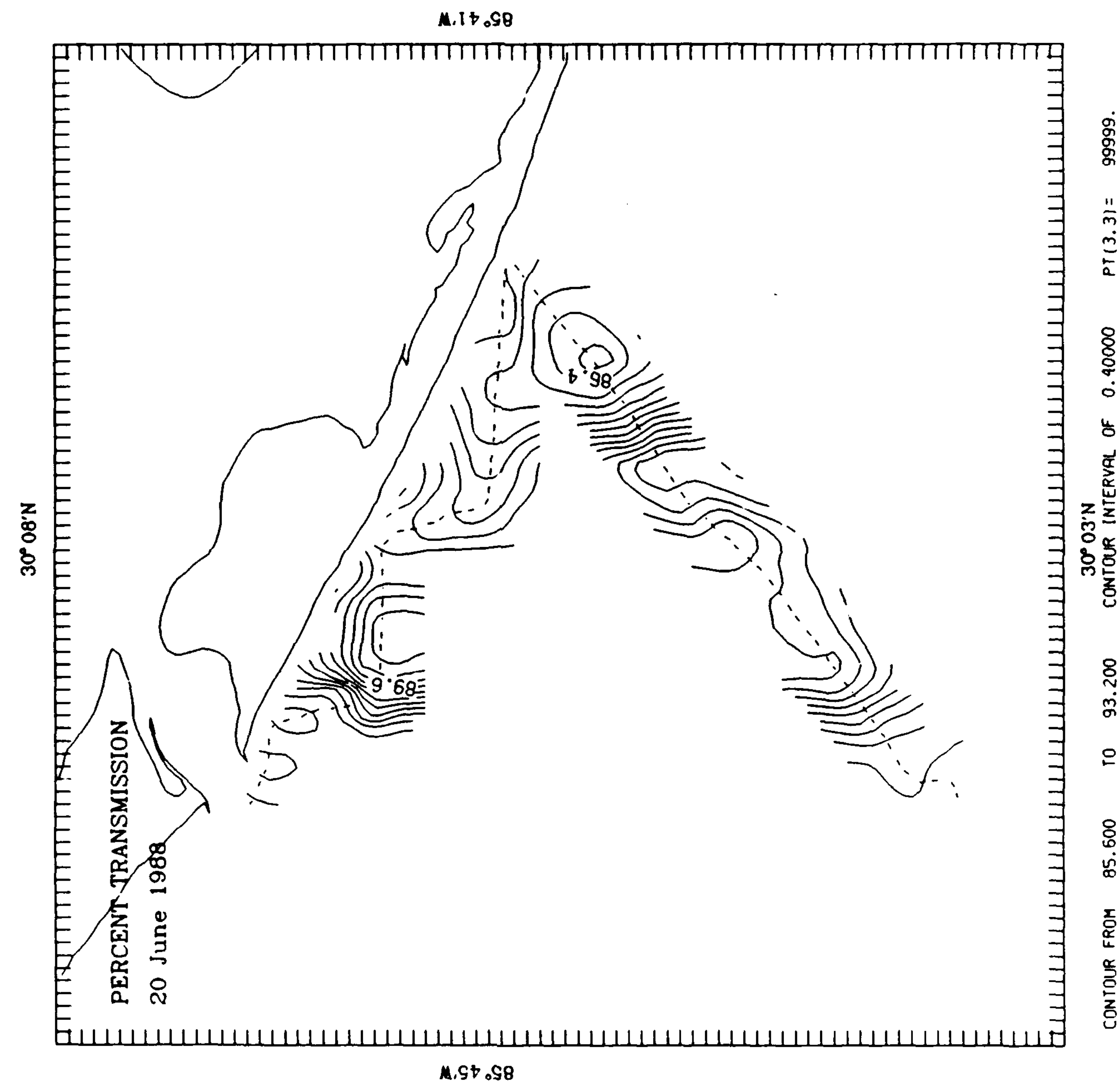


TESS PYROMETER 1
19 June 1988
85°40'W
85°48'W
30°06'N
30°02'N
8.40
7.20
9.00
CONTOUR FROM 3.9000 TO 9.3000 CONTOUR INTERVAL OF 0.30000 PT(3,3)= 99999.


85°40'W
85°46'W
30°06'N
30°02'N
TESS PYROMETER 2
19 June 1988
8.40
7.20
CONTOUR FROM 3.9000 TO 9.3000 CONTOUR INTERVAL OF 0.30000 PT(3,3)= 99999.

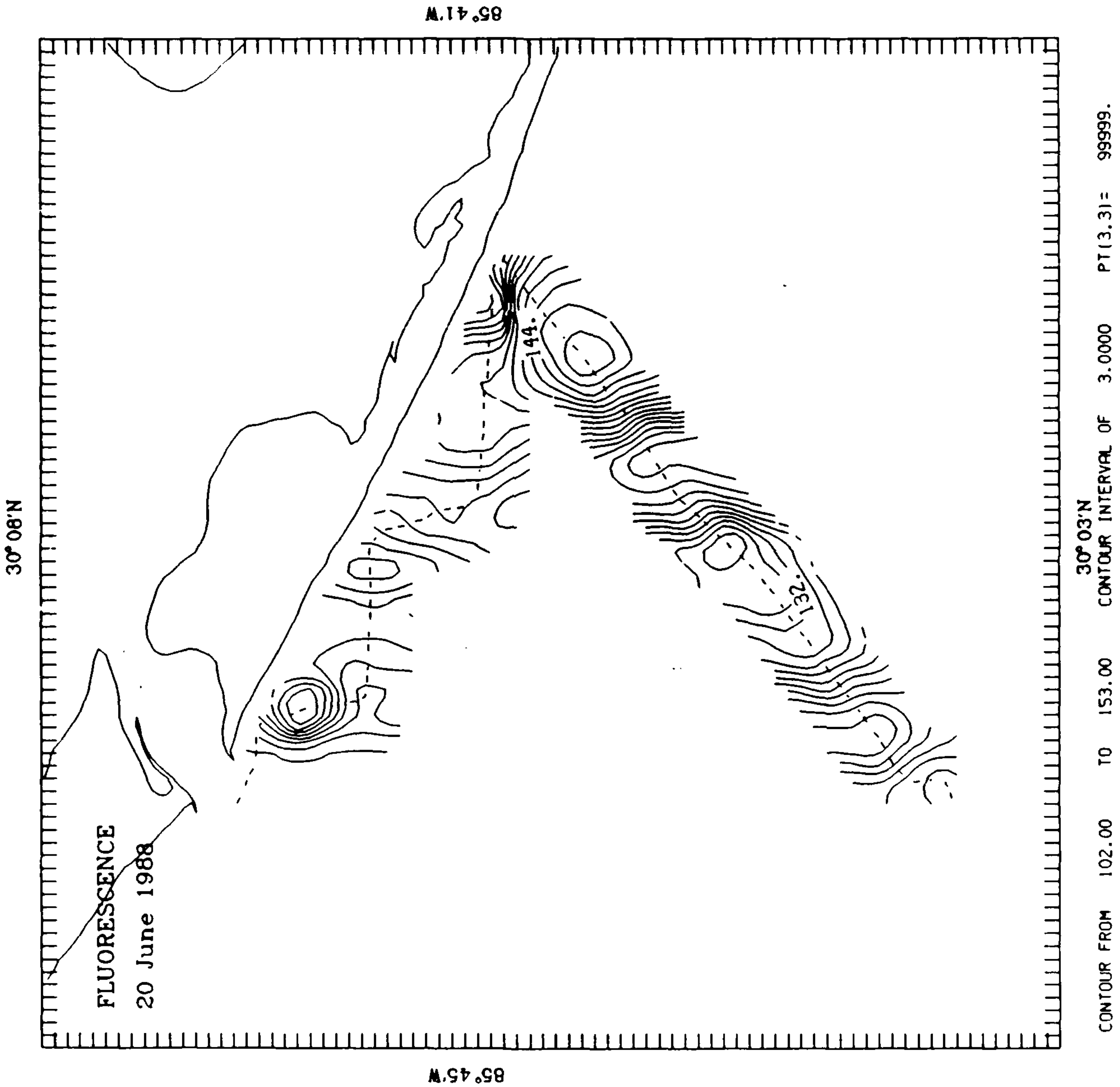

85°41'W
30°08'N
30°03'N
85°45'W
DEPTH
20 June 1988
8.00
8.00
CONTOUR FROM 3.0000 TO 21.000 CONTOUR INTERVAL OF 1.0000 PT(3,3)= 99999.


85°41'W
85°45'W
30°08'N
30°03'N
TEMPERATURE
20 June 1988
27.4
CONTOUR FROM 26.560 TO 27.840 CONTOUR INTERVAL OF 0.80000E-01 PT(3,3)= 99999.

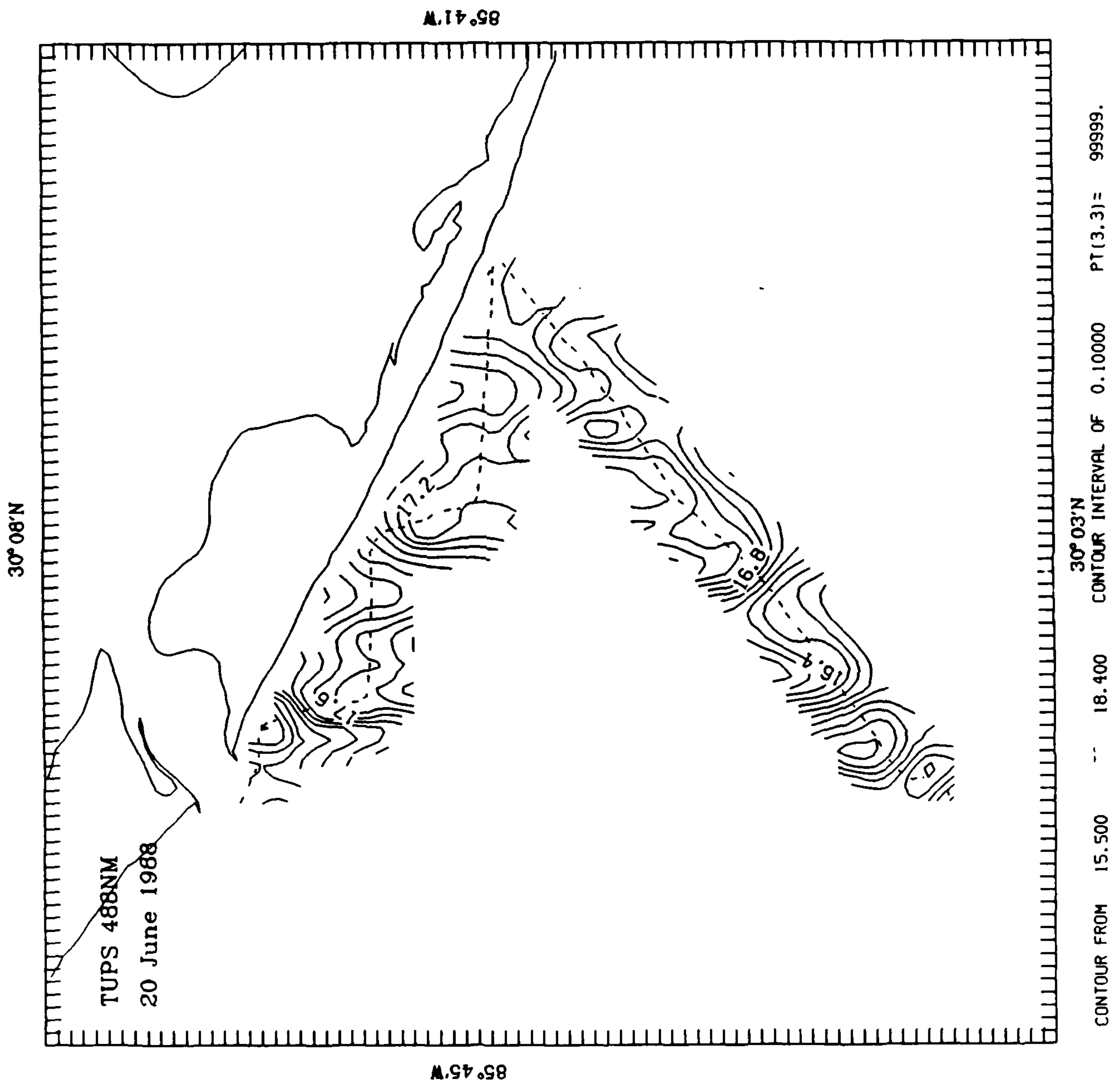


85°41'W
30°08'N
30°03'N
85°45'W
85.4
89.6
PERCENT TRANSMISSION
20 June 1988
CONTOUR FROM 85.600 TO 93.200 CONTOUR INTERVAL OF 0.40000 PT(3,3)= 99999.

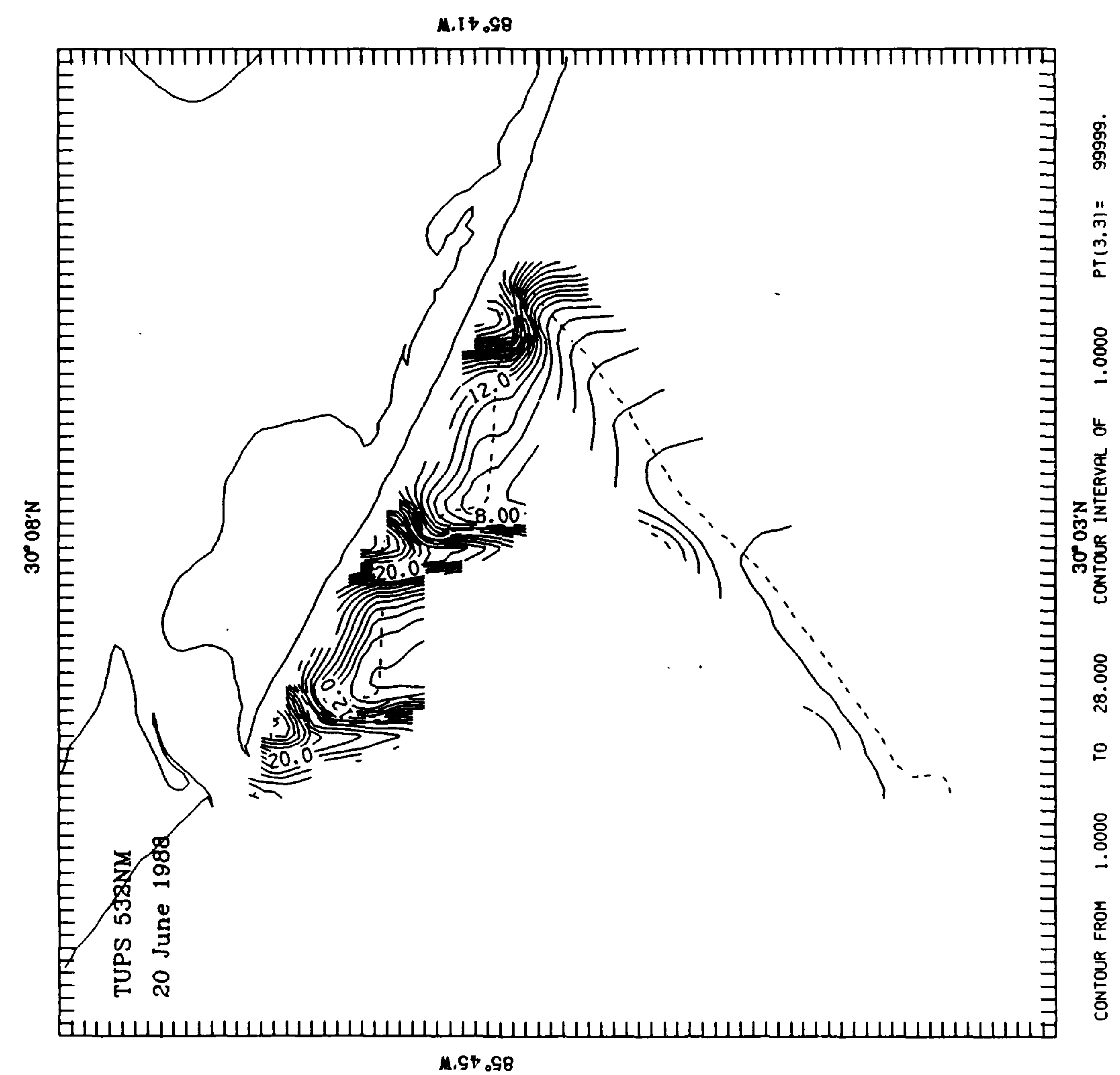
85°41'W
30°08'N
30°03'N
85°45'W
SALINITY
20 June 1988
34.1
33.9
CONTOUR FROM 33.890 TO 34.130 CONTOUR INTERVAL OF 0.10000E-01 PT(3,3)= 99999.

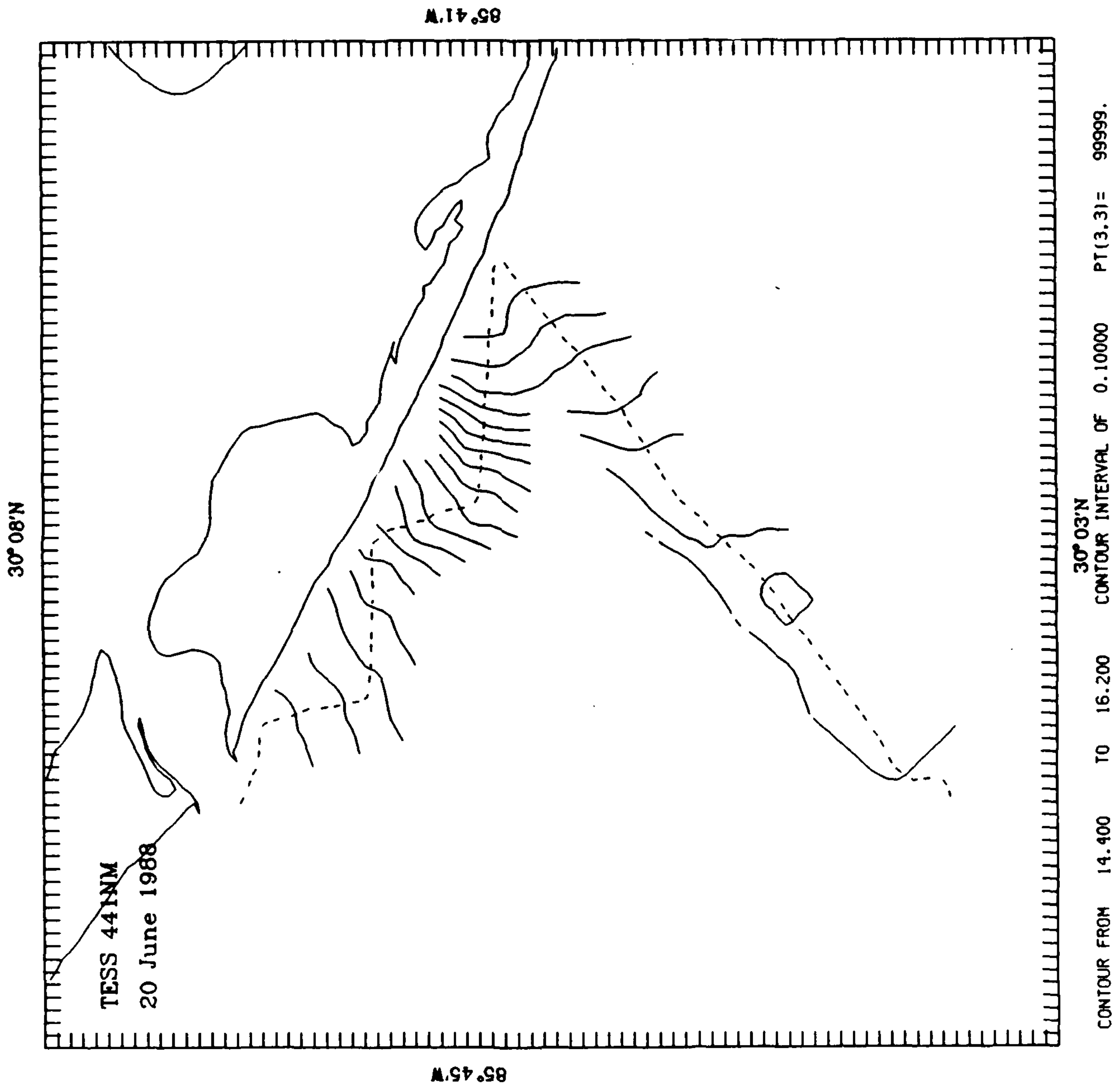

85°41'W
30°08'N
30°03'N
85°45'W
144.
132.
FLUORESCENCE
20 June 1988
CONTOUR FROM 102.00 TO 153.00 CONTOUR INTERVAL OF 3.0000 PT(3,3)= 99999.

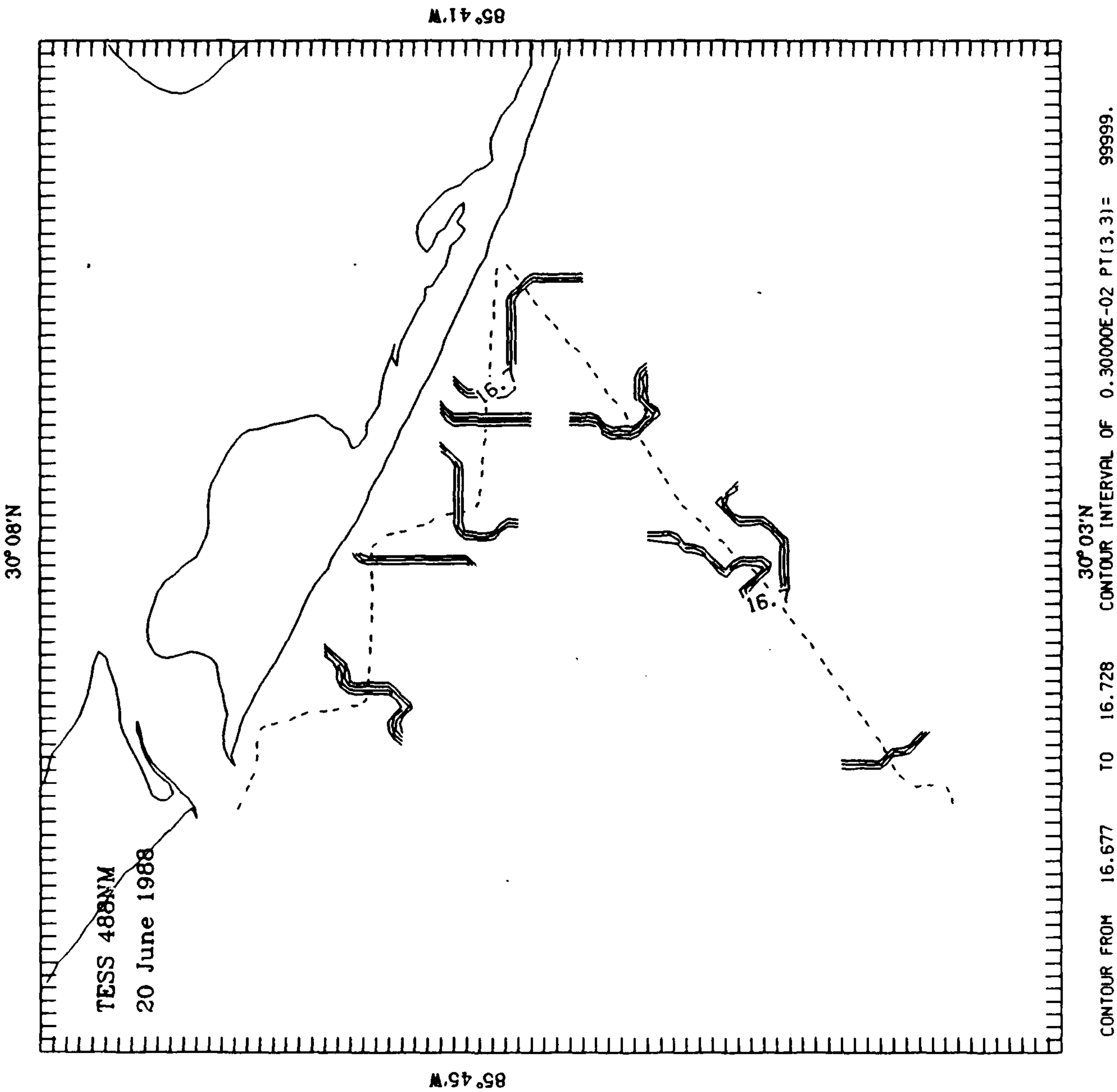

85°41'W
30°08'N
30°03'N
85°45'W
TUPS 465NM
20 June 1988
CONTOUR FROM 1.0000 TO 21.000 CONTOUR INTERVAL OF 1.0000 PT(3,3)= 99999.

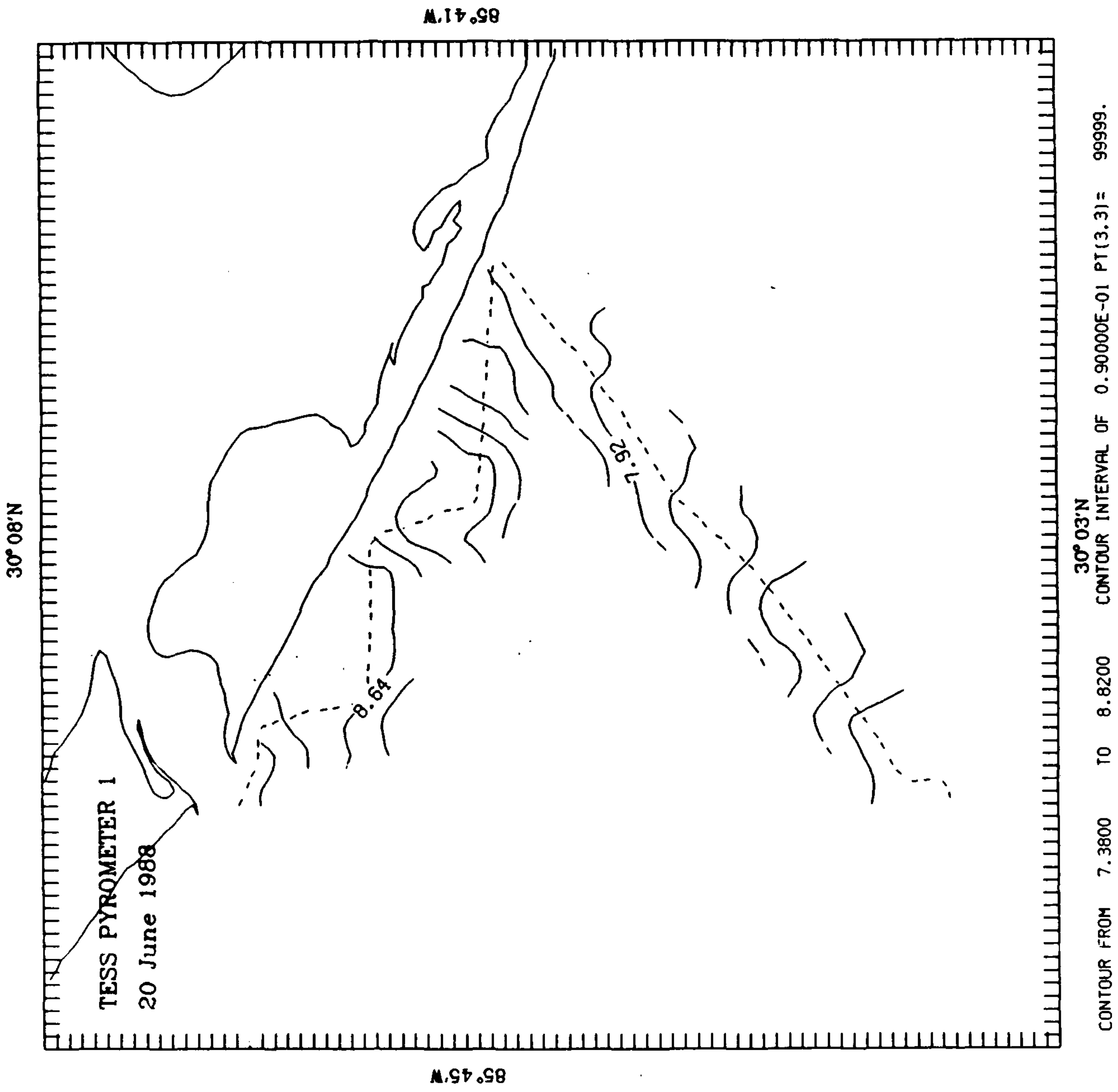

85°41'W
30°08'N
30°03'N
85°45'W
TUPS 488NM
20 June 1988
17.2
16.8
CONTOUR FROM 15.500 -- 18.400 CONTOUR INTERVAL OF 0.10000 PT(3,3)= 99999.

CONTOUR FROM 2.0000 TO 27.000 CONTOUR INTERVAL OF 1.0000 PT(3,3)= 99999.

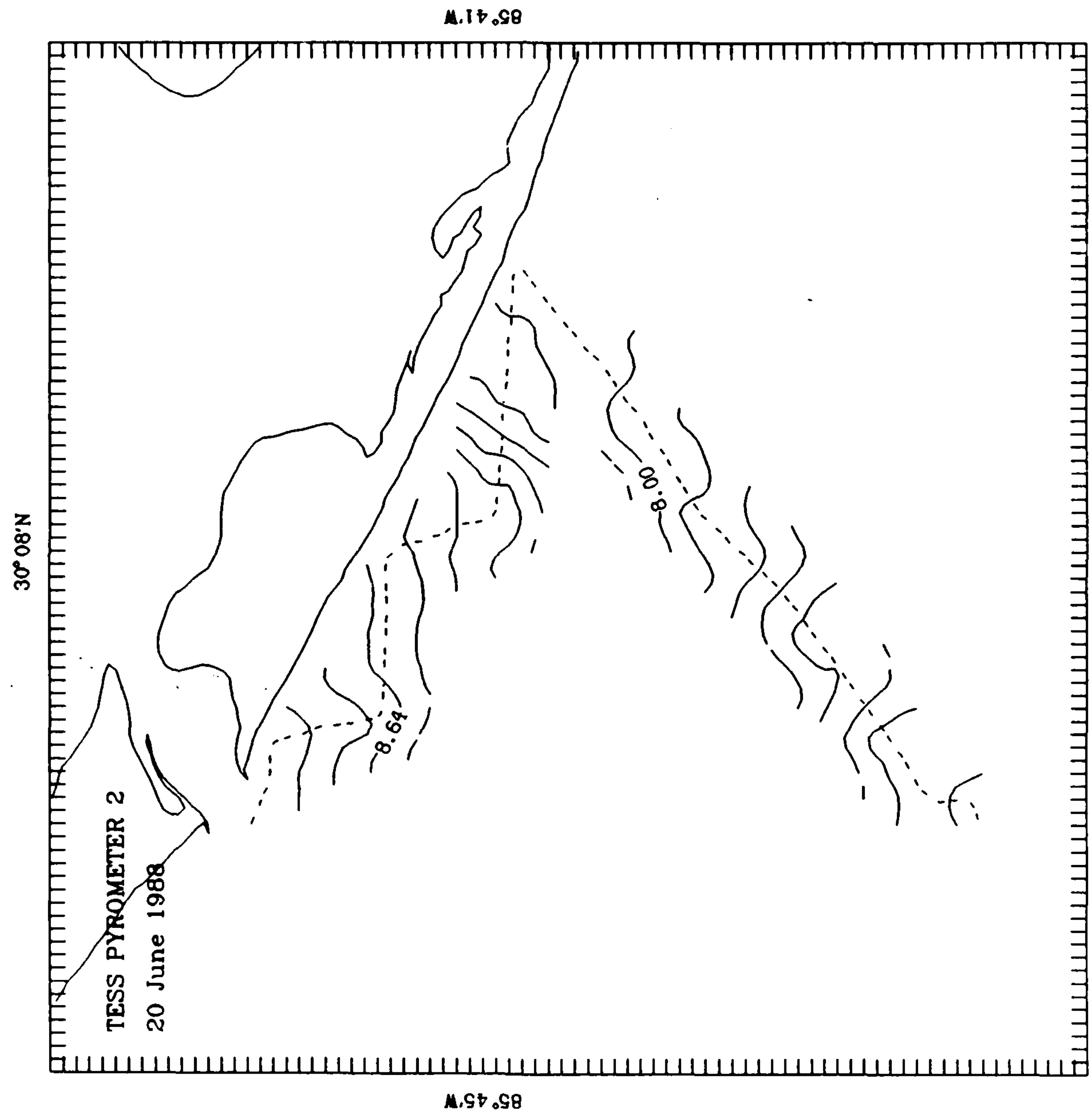

85°41'W
85°45'W
30°08'N
30°03'N
TUPS 532NM
20 June 1988
12.0
8.00
20.0
20.0
CONTOUR FROM 1.0000 TO 28.000 CONTOUR INTERVAL OF 1.0000 PT(3,3)= 99999.


85°41'W
30°08'N
30°03'N
85°45'W
TESS 44 NM
20 June 1988
CONTOUR FROM 14.400 TO 16.200 CONTOUR INTERVAL OF 0.10000 PT(3,3)= 99999.

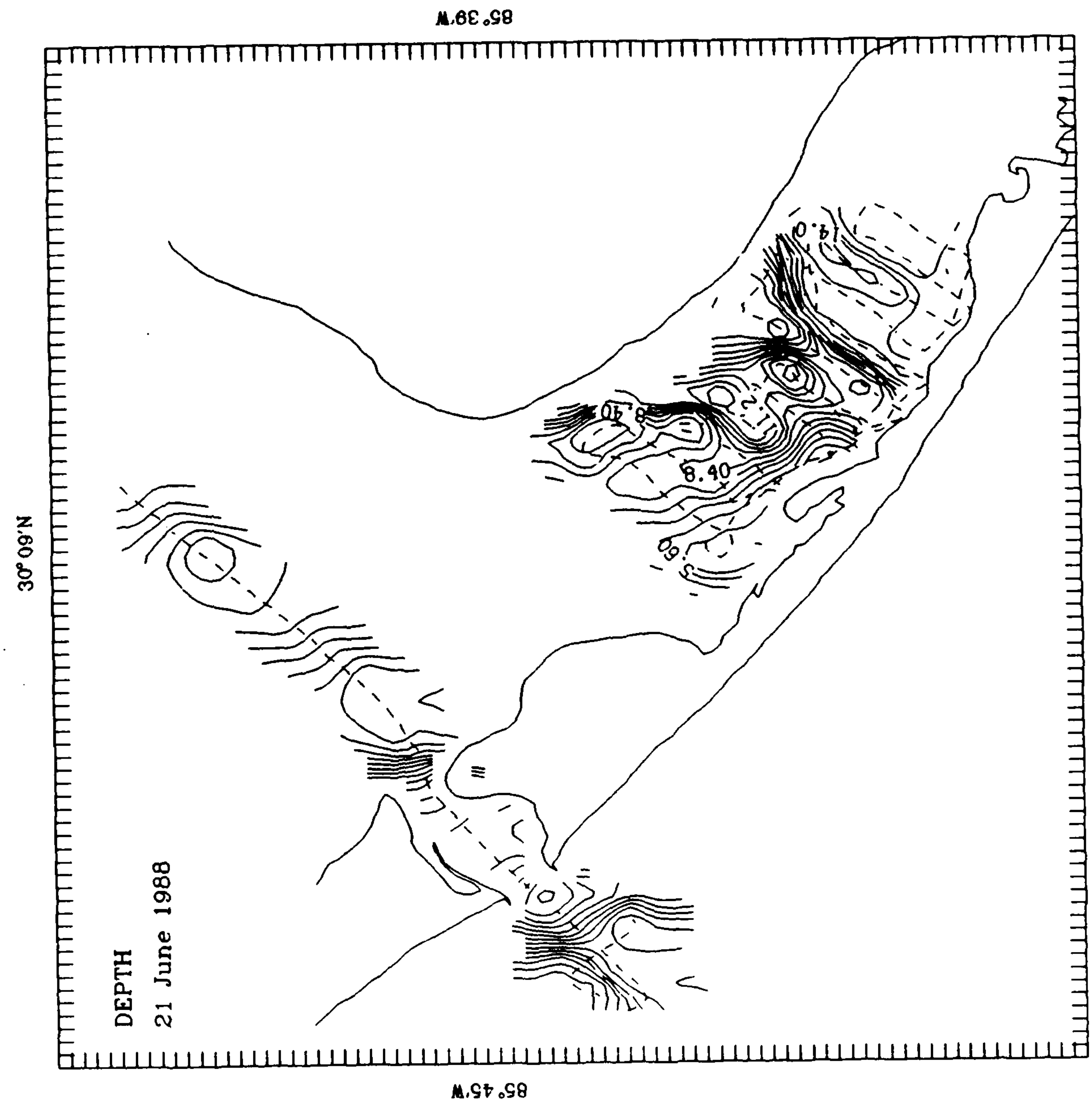

85°41'W
85°45'W
30°08'N
30°03'N
16.7
16.
TESS 488NM
20 June 1988
CONTOUR FROM 16.677 TO 16.728 CONTOUR INTERVAL OF 0.30000E-02 PT(3,3)= 99999.



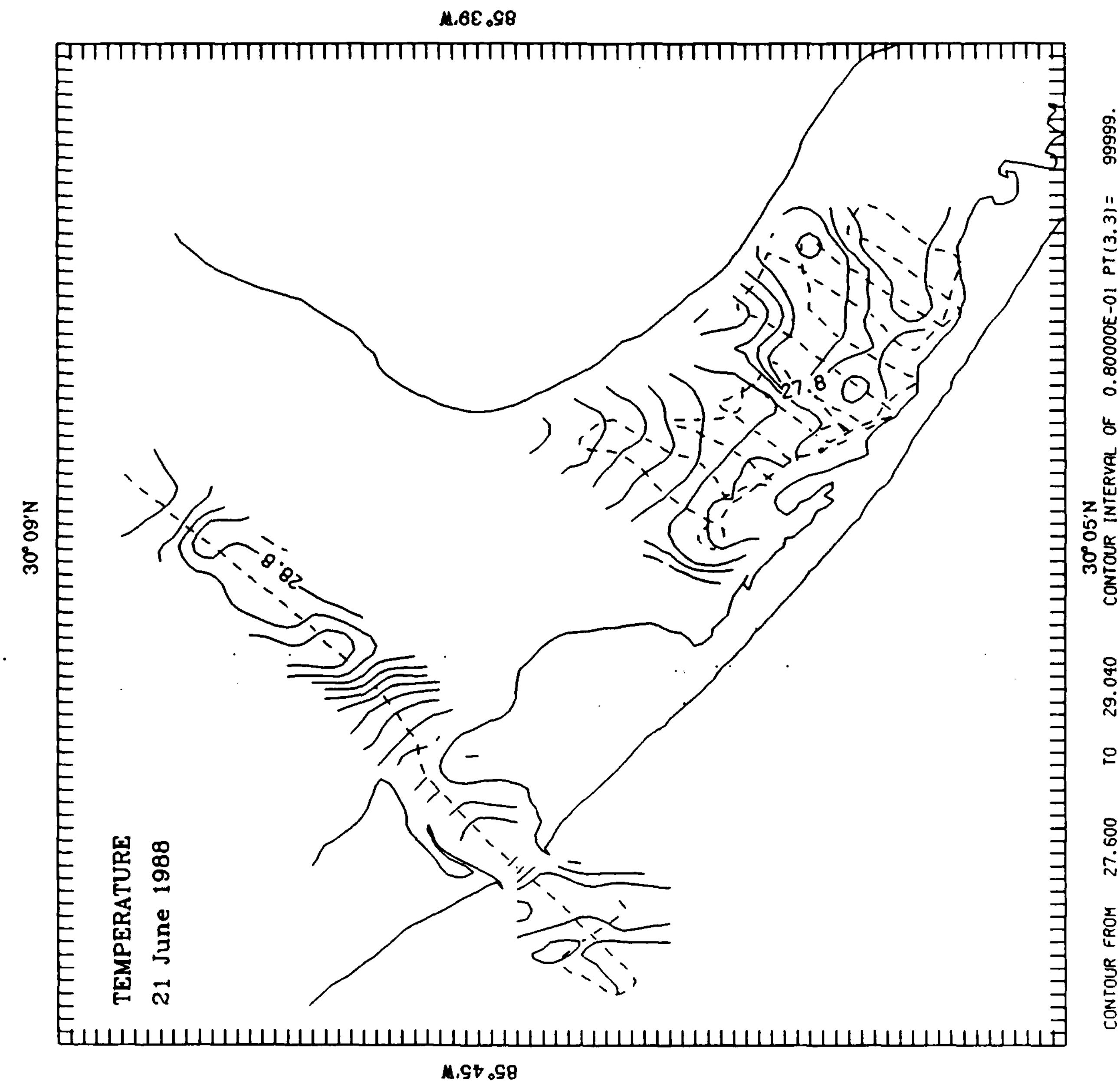
85°41'W
85°45'W
30°08'N
30°03'N
TESS PYROMETER 1
20 June 1988
8.64
7.92
CONTOUR FROM 7.3800 TO 8.8200 CONTOUR INTERVAL OF 0.90000E-01 PT(3,3)= 99999.



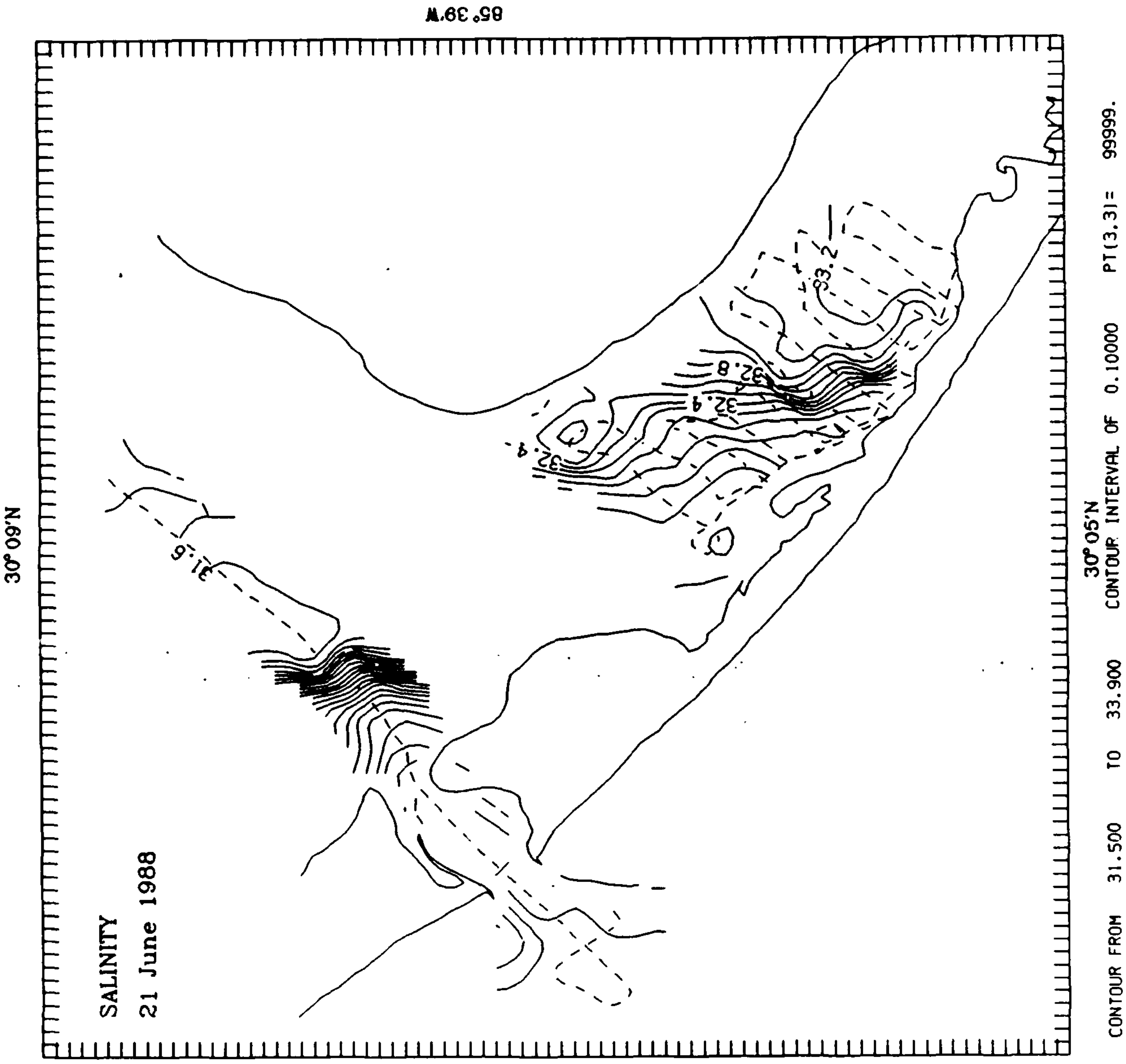
CONTOUR FROM 7.3600 TO 8.8000 CONTOUR INTERVAL OF 0.80000E-01 PT(3,3)= 99999.

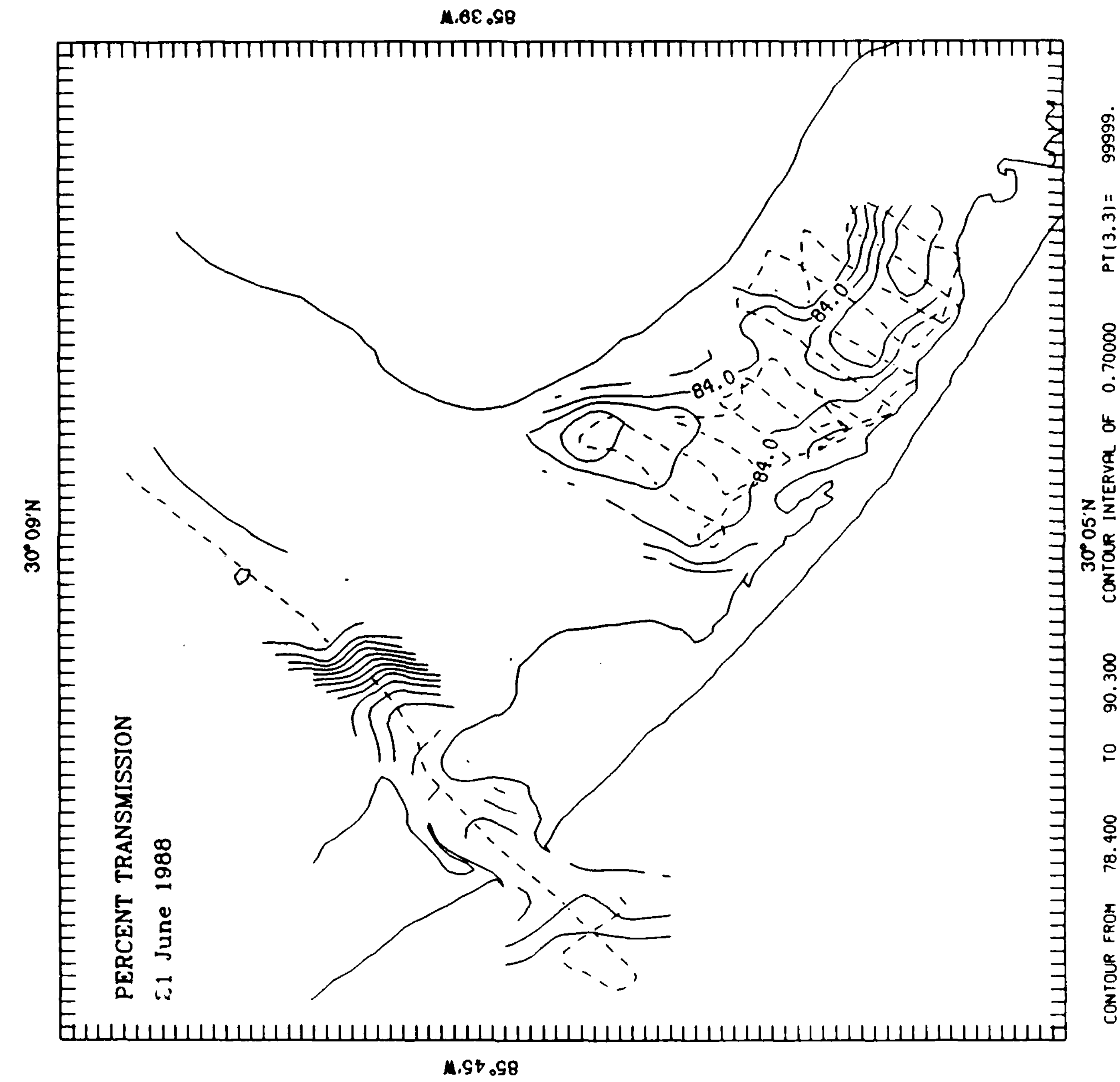


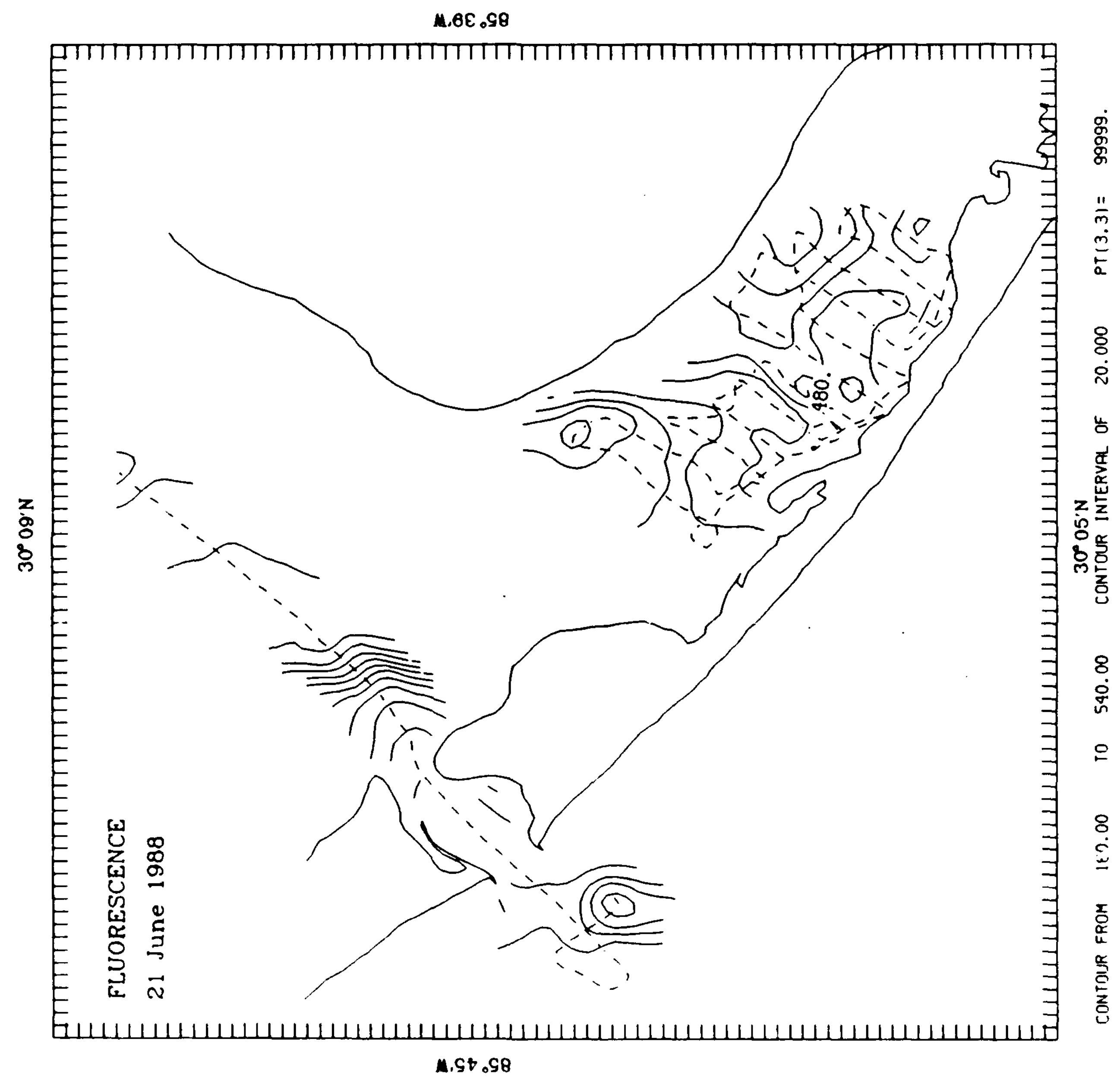
CONTOUR FROM 3.5000 TO 16.100 CONTOUR INTERVAL OF 0.70000 PT(3,3)= 99999.



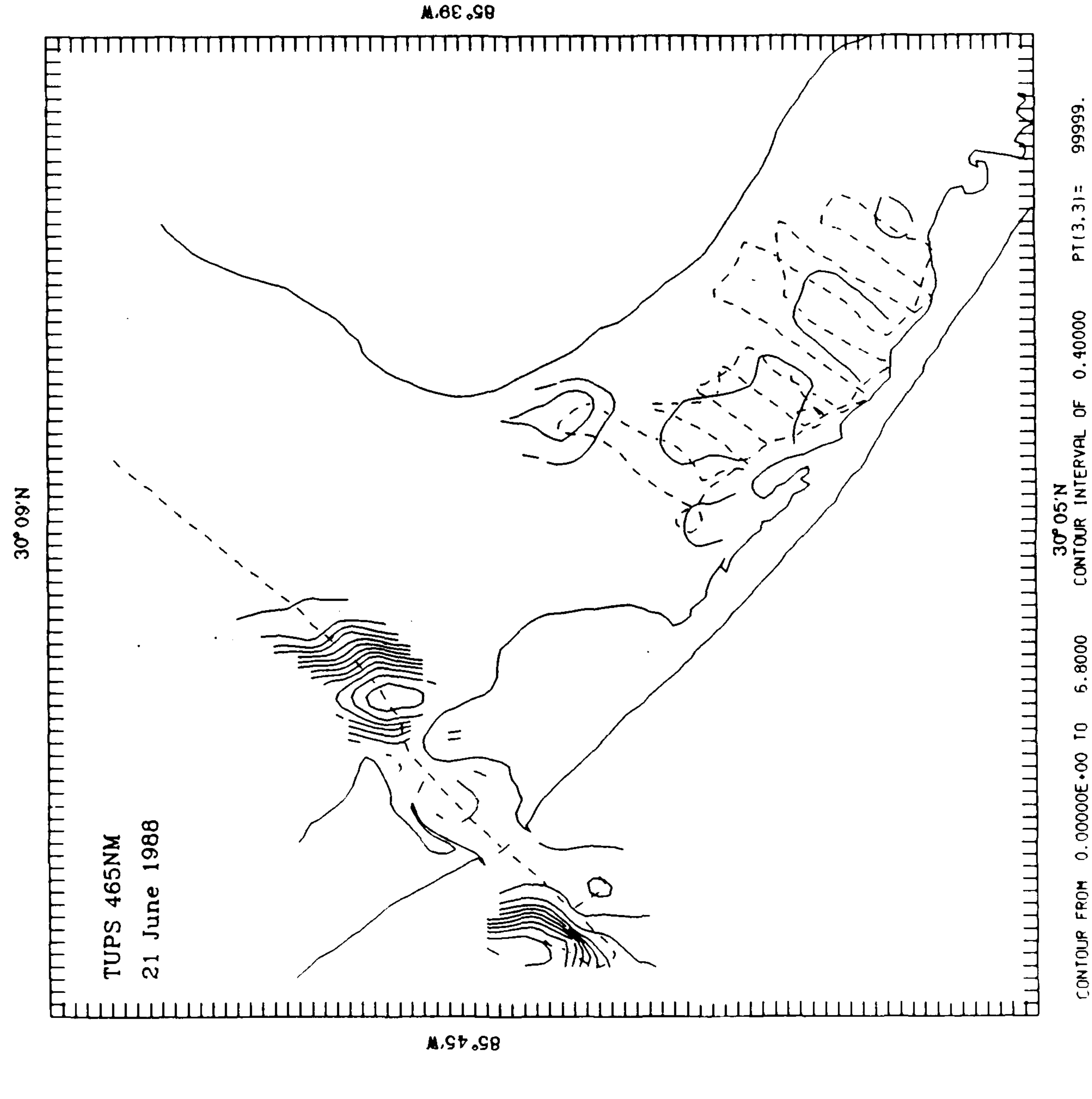
85°39'W
30°09'N
30°05'N
85°45'W
TEMPERATURE
21 June 1988
28.8
27.8
CONTOUR FROM 27.600 TO 29.040 CONTOUR INTERVAL OF 0.80000E-01 PT(3,3)= 99999.


SALINITY
21 June 1988
85° 39'W
85° 45'W
30° 09'N
30° 05'N
31.6
32.4
32.8
33.2
CONTOUR FROM 31.500 TO 33.900 CONTOUR INTERVAL OF 0.10000 PT(3,3)= 99999.

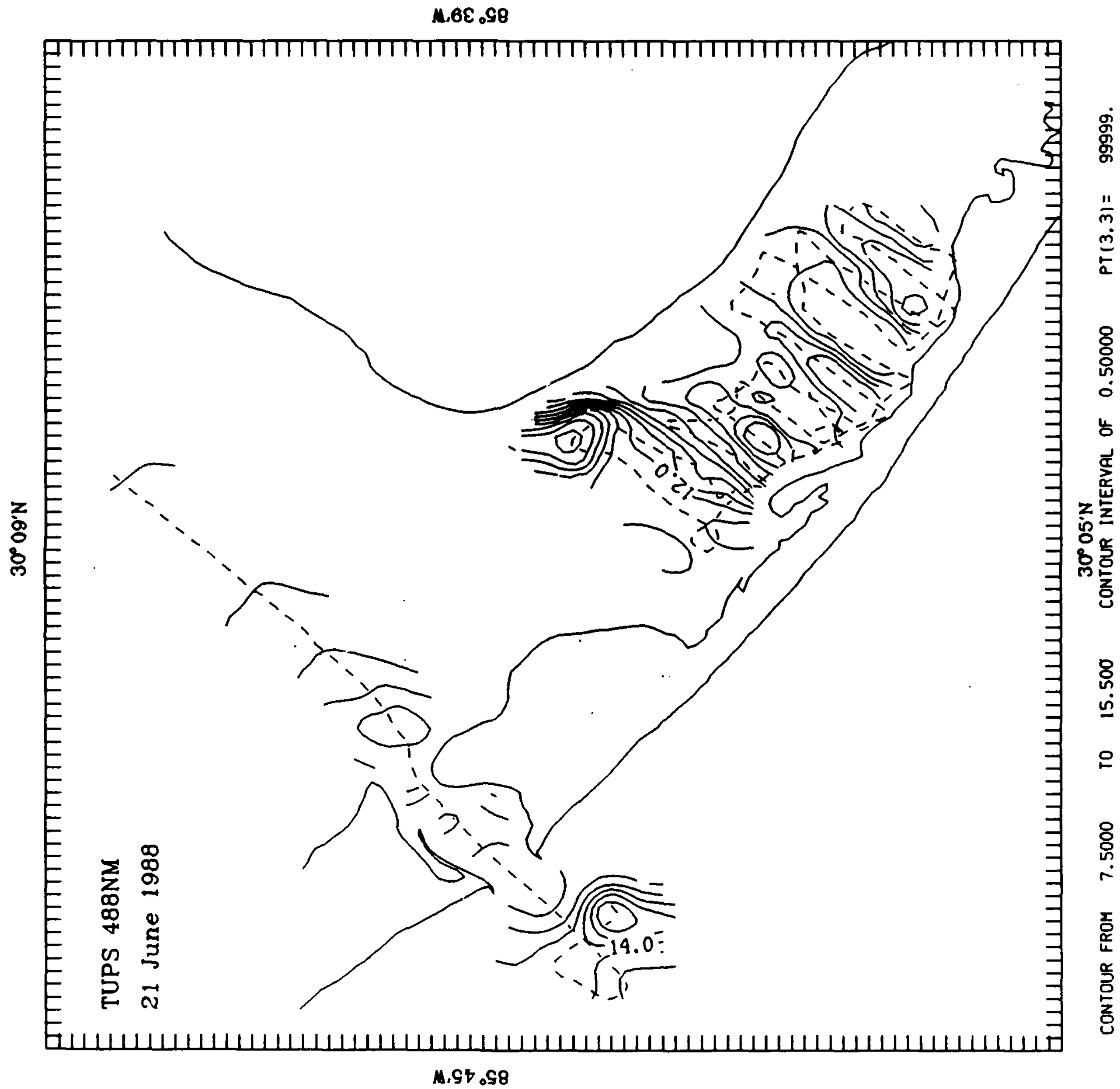

85° 39'W
85° 45'W
30° 09'N
30° 05'N
PERCENT TRANSMISSION
21 June 1988
84.0
84.0
84.0
84.0
CONTOUR FROM 78.400 TO 90.300 CONTOUR INTERVAL OF 0.70000 PT(3,3)= 99999.

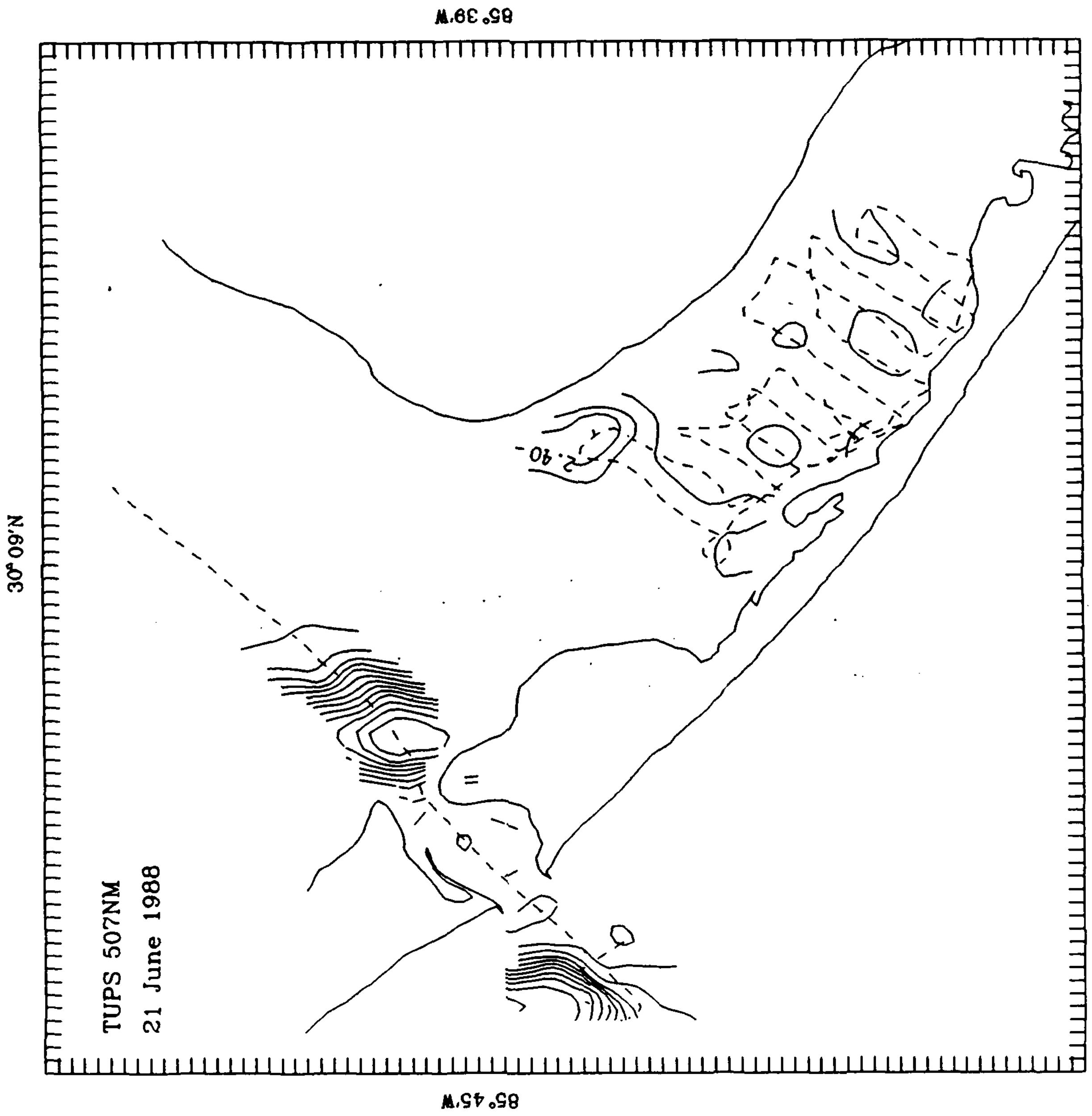


FLUORESCENCE
21 June 1988
85°39'W
85°45'W
30°09'N
30°05'N
480.
CONTOUR FROM
TO 540.00
CONTOUR INTERVAL OF 20.000
PT(3,3)= 99999.

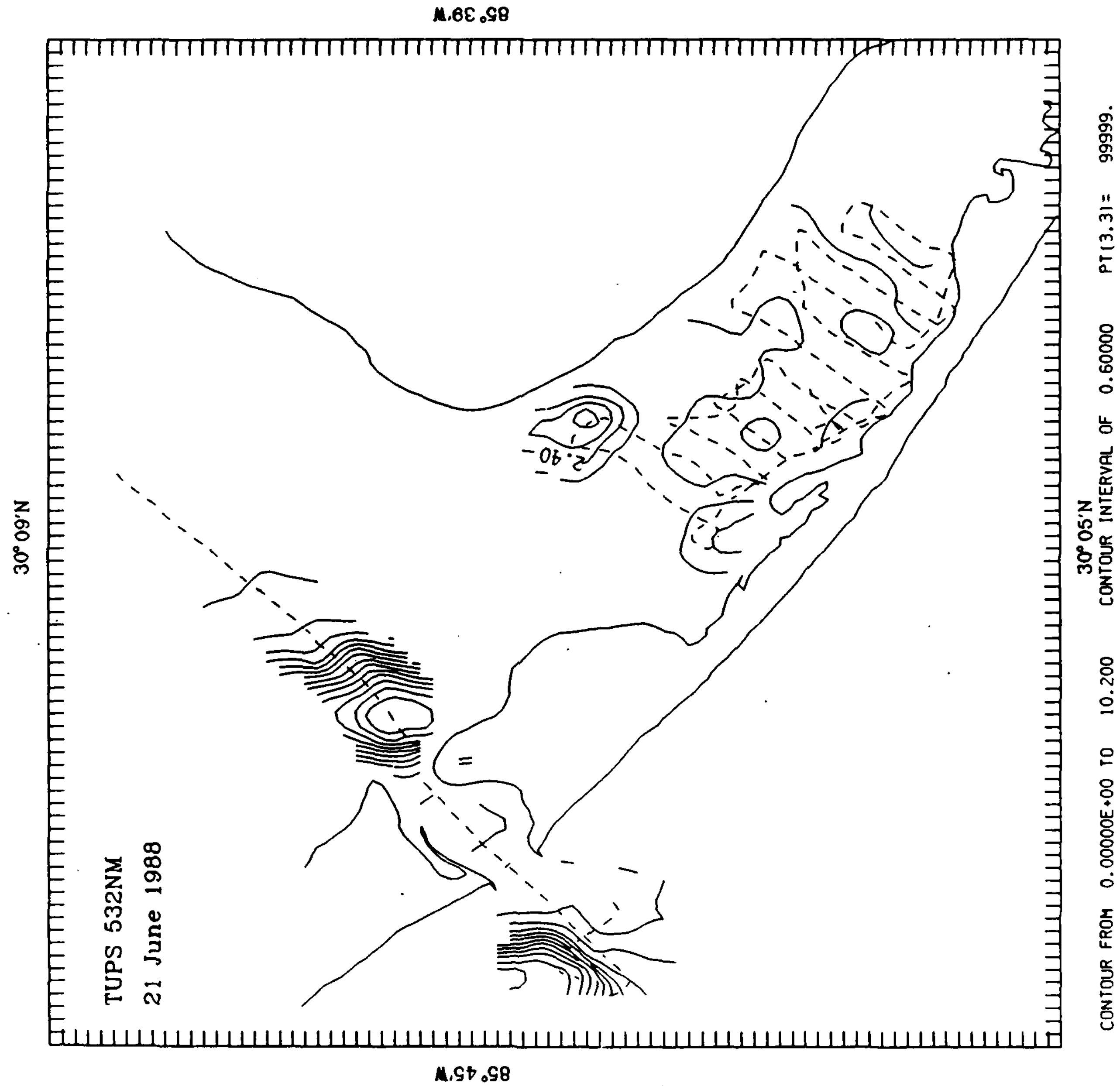


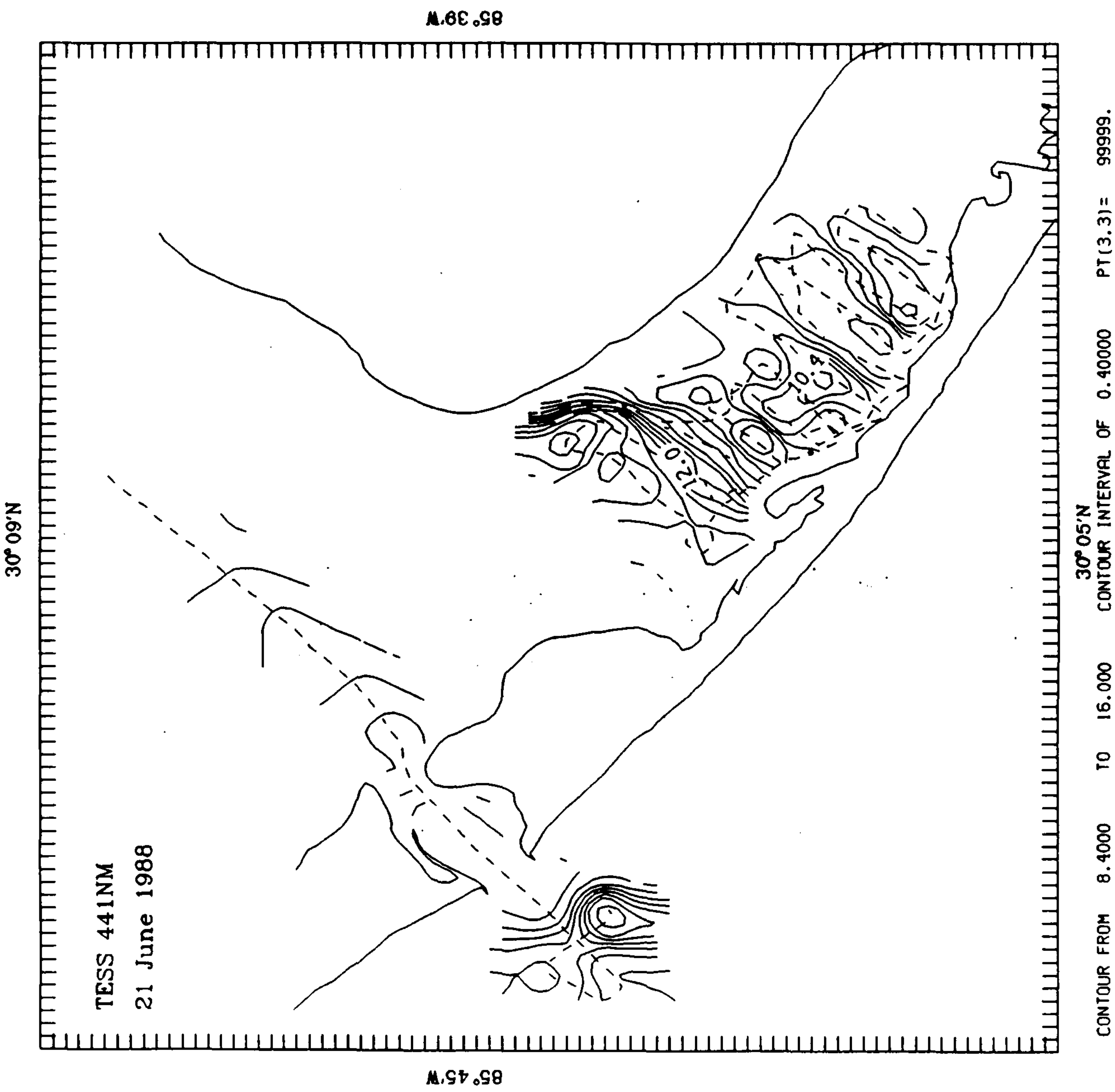
85° 39'W
85° 45'W
30° 09'N
30° 05'N
TUPS 465NM
21 June 1988
CONTOUR FROM 0.00000E+00 TO 6.8000 CONTOUR INTERVAL OF 0.40000 PT(3,3)= 99999.

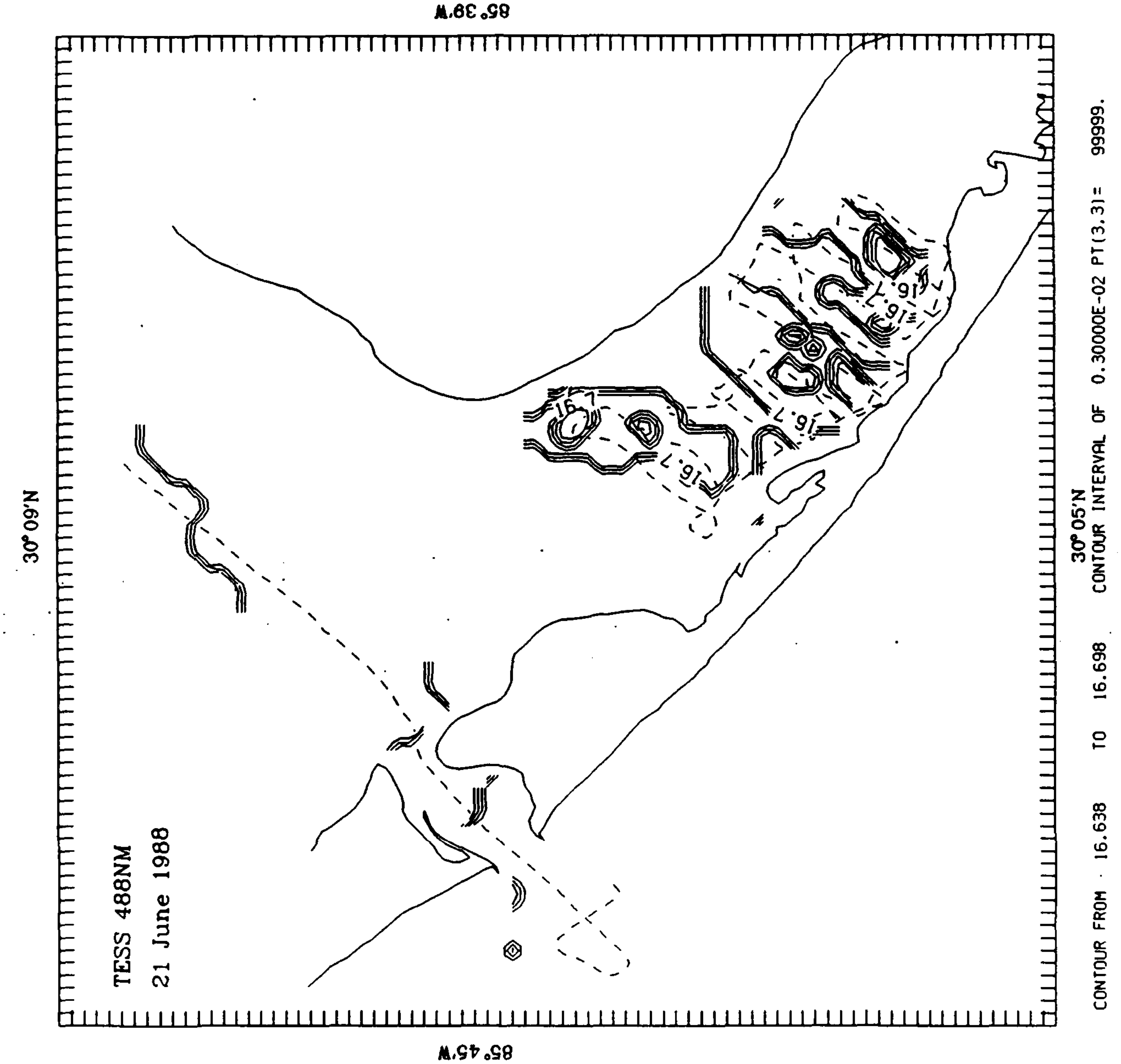

TUPS 488NM
21 June 1988
85°39'W
85°45'W
30°09'N
30°05'N
12.0
14.0
CONTOUR FROM 7.5000 TO 15.500 CONTOUR INTERVAL OF 0.50000 PT(3,3)= 99999.

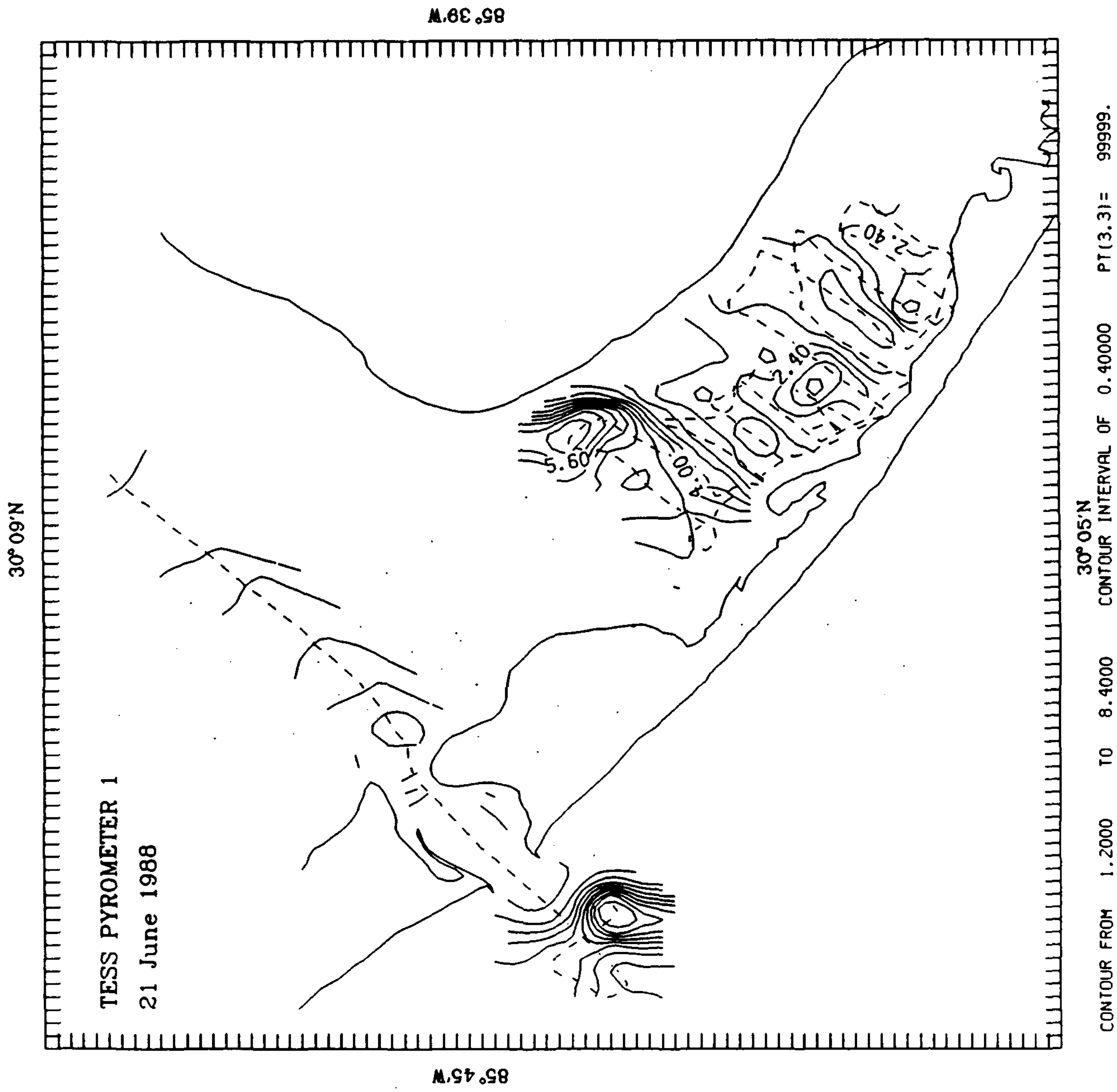


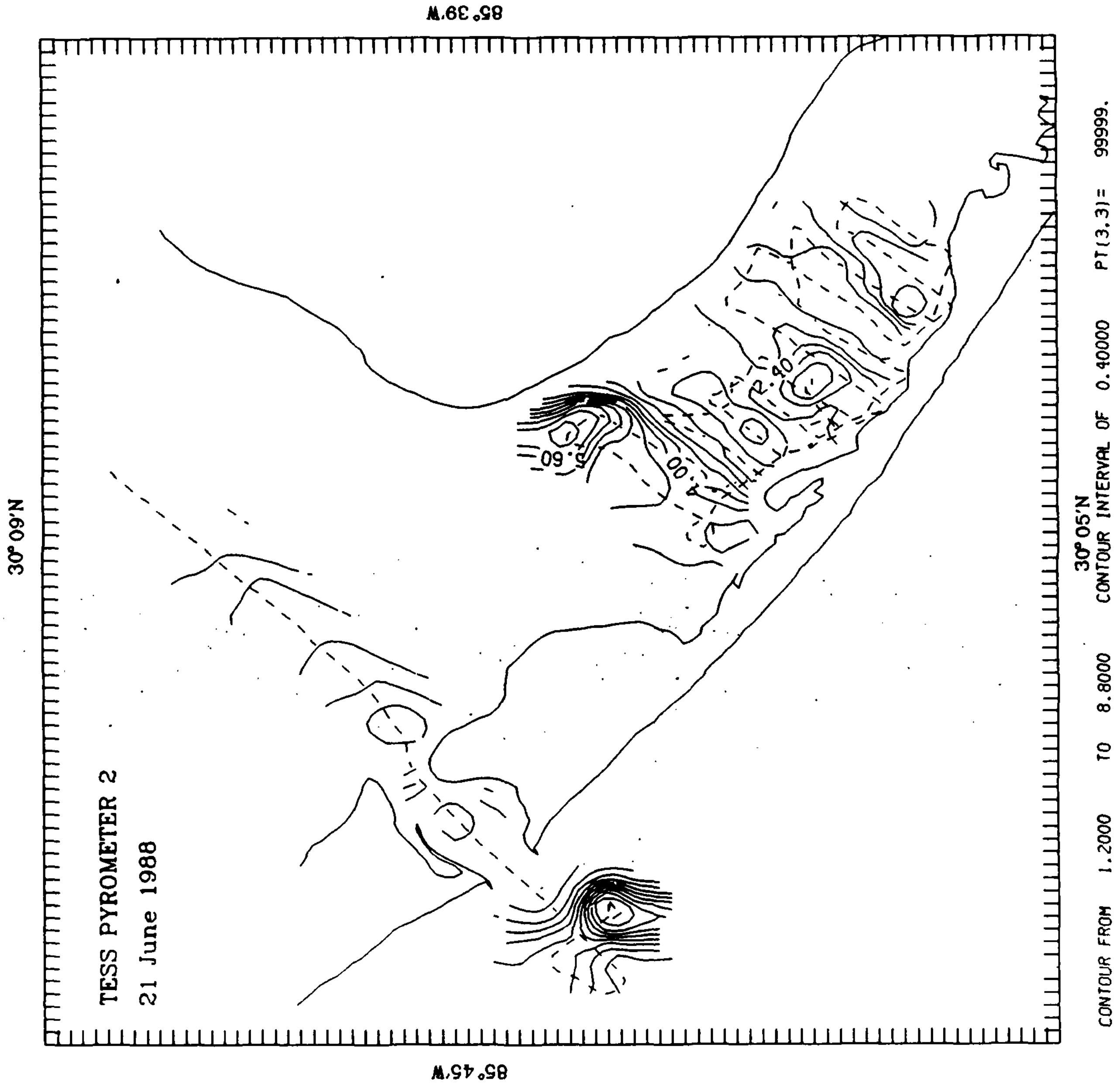
CONTOUR FROM 0.00000E+00 TO 10.200 CONTOUR INTERVAL OF 0.60000 PT(3,3)= 99999.


85°39'W
30°09'N
30°05'N
85°45'W
TUPS 532NM
21 June 1988
2.40
CONTOUR FROM 0.00000E+00 TO 10.200 CONTOUR INTERVAL OF 0.60000 PT(3,3)= 99999.


85°39'W
85°45'W
30°09'N
30°05'N
TESS 441NM
21 June 1988
12.0
10.4
CONTOUR FROM 8.4000 TO 16.000 CONTOUR INTERVAL OF 0.40000 PT(3,3)= 99999.


TESS 488NM
21 June 1988
85° 39'W
85° 45'W
30°09'N
30°05'N
16.7
CONTOUR FROM 16.638 TO 16.698 CONTOUR INTERVAL OF 0.30000E-02 PT(3,3)= 99999.


TESS PYROMETER 1
21 June 1988
85° 39'W
85° 45'W
30° 09'N
30° 05'N
5.60
4.00
2.40
2.40
CONTOUR FROM 1.2000 TO 8.4000 CONTOUR INTERVAL OF 0.40000 PT(3,3)= 99999.


TESS PYROMETER 2
21 June 1988
85° 39'W
85° 45'W
30° 09'N
30° 05'N
5.60
4.00
2.40
CONTOUR FROM 1.2000 TO 8.8000 CONTOUR INTERVAL OF 0.40000 PT(3,3)= 99999.

APPENDIX C

VAX 9–TRACK TAPE LISTING

```
Listing of save set(s)

Save set:           PCITY.BCK
Written by:         DENIS
UIC:                [000200,000007]
Date:               28-DEC-1988 14:30:50.31
Command:            BACKUP [DENIS.PCITY...]/LIST=ARNONE.LIS MUB0:PCITY.BCK/SAVE_SET
Operating system:   VAX/VMS version V4.7
BACKUP version:     V4.7
CPU ID register:    08000000
Node name:          _GERGA::
Written on:         _GERGA$MUB0:
Block size:         8192
Group size:         10
Buffer count:       3

[DENIS.PCITY]19J1600.CNV;3                                166  12-JUL-1988 12:09
[DENIS.PCITY]19J1600.TIM;2                                 31  29-JUN-1988 08:41
[DENIS.PCITY]19J1652.CNV;3                                655  12-JUL-1988 12:13
[DENIS.PCITY]19J2022.CNV;3                                287  12-JUL-1988 12:14
[DENIS.PCITY]19JUN88.FIN;1                               1727  28-NOV-1988 11:41
[DENIS.PCITY]19JUN88.PTO;1                                933  28-NOV-1988 11:39
[DENIS.PCITY]19JUN88.TES;1                                565  11-JUL-1988 11:00
[DENIS.PCITY]19JUN88.TUP;3                               1106  12-JUL-1988 12:34
[DENIS.PCITY]19JUN881.RDJ;1                               386  11-JUL-1988 09:51
[DENIS.PCITY]19JUN882.RDJ;1                               179  11-JUL-1988 09:54
[DENIS.PCITY]20J1505.CNV;1                                226   3-NOV-1988 09:19
[DENIS.PCITY]20JUN88.FIN;2                                353  28-NOV-1988 11:18
[DENIS.PCITY]20JUN88.PTO;1                                191  28-NOV-1988 11:17
[DENIS.PCITY]20JUN88.TES;1                                247  11-JUL-1988 11:05
[DENIS.PCITY]20JUN88.TUP;1                                226   3-NOV-1988 09:26
[DENIS.PCITY]20JUN881.RDJ;1                               247  11-JUL-1988 10:01
[DENIS.PCITY]21J1155.CNV;1                                158  12-JUL-1988 12:39
[DENIS.PCITY]21J1250.CNV;1                                196  12-JUL-1988 12:40
[DENIS.PCITY]21J1353.CNV;1                                118  12-JUL-1988 12:40
[DENIS.PCITY]21J1441.CNV;1                                 63  12-JUL-1988 12:41
[DENIS.PCITY]21J1519.CNV;1                                106  12-JUL-1988 12:41
[DENIS.PCITY]21J1602.CNV;1                                 61  12-JUL-1988 12:42
[DENIS.PCITY]21J1630.CNV;1                                170  12-JUL-1988 12:42
[DENIS.PCITY]21J1742.CNV;1                                 63  12-JUL-1988 12:43
[DENIS.PCITY]21J1839.CNV;1                                149  12-JUL-1988 12:43
[DENIS.PCITY]21JUN88.FIN;1                               1681  28-NOV-1988 12:01
[DENIS.PCITY]21JUN88.PTO;1                                908  28-NOV-1988 11:59
[DENIS.PCITY]21JUN88.TES;3                                577  18-JUL-1988 14:03
[DENIS.PCITY]21JUN88.TUP;1                               1077  12-JUL-1988 12:55
[DENIS.PCITY]21JUN881.RDJ;1                               112  11-JUL-1988 10:02
[DENIS.PCITY]21JUN882.RDJ;1                                77  11-JUL-1988 10:03
[DENIS.PCITY]21JUN883.RDJ;1                               136  11-JUL-1988 10:04
[DENIS.PCITY]21JUN884.RDJ;1                               140  18-JUL-1988 13:33
[DENIS.PCITY]21JUN885.RDJ;1                               116  18-JUL-1988 13:35
[DENIS.PCITY]ADDNUM.EXE;3                                   6   2-DEC-1988 08:32
[DENIS.PCITY]ADDNUM.LIS;4                                   5   2-DEC-1988 08:32
[DENIS.PCITY]ALL.SSD;2                                   4224  29-NOV-1988 11:00
[DENIS.PCITY]ALL19.NAV;1                                 1075  30-NOV-1988 16:40
[DENIS.PCITY]ALL20.NAV;1                                  220  12-DEC-1988 09:01
[DENIS.PCITY]ALL21.NAV;1                                 1038  12-DEC-1988 09:09
[DENIS.PCITY]ALLSUB.SSD;2                                2416  22-DEC-1988 08:40
[DENIS.PCITY]ARNONE.LIS;1                                   3  28-DEC-1988 14:25
[DENIS.PCITY]BEND.OUT;59                                    2  19-JUL-1988 22:20
[DENIS.PCITY]BEND.OUT;58                                    2  19-JUL-1988 22:20
```

```
[DENIS.PCITY]BEND.OUT;57                        2  19-JUL-1988 22:20
[DENIS.PCITY]BSAS.COM;6                         1  23-NOV-1988 07:42
[DENIS.PCITY]CONTOUR.COM;3                      1  20-DEC-1988 15:26
[DENIS.PCITY]CONTOUR.COM;2                      1  20-DEC-1988 15:18
[DENIS.PCITY]CONTOUR.COM;1                      1   9-DEC-1988 08:41
[DENIS.PCITY]CONTOUR.EXE;121                  202  21-DEC-1988 14:29
[DENIS.PCITY]CONTOUR.FOR;159                   22  21-DEC-1988 11:24
[DENIS.PCITY]CONTOUR.IOP;9                     29  29-NOV-1988 08:27
[DENIS.PCITY]CONTOUR.LIS;122                   75  21-DEC-1988 14:28
[DENIS.PCITY]CORR.CLN;2                         4  21-DEC-1988 15:37
[DENIS.PCITY]CORR.CLN;1                         4  21-DEC-1988 15:35
[DENIS.PCITY]CORR.LIS;2                        12  21-DEC-1988 15:33
[DENIS.PCITY]CORR.LOG;4                         2  21-DEC-1988 15:30
[DENIS.PCITY]DAT.DIR;1                          2  28-NOV-1988 09:49
[DENIS.PCITY.DAT]19J1600.DAT;1                 98  24-JUN-1988 14:15
[DENIS.PCITY.DAT]19J1652.DAT;1                389  11-JUL-1988 14:40
[DENIS.PCITY.DAT]19J2022.DAT;1                170  24-JUN-1988 14:36
[DENIS.PCITY.DAT]19JUN881.DAT;1               586  25-JUN-1988 14:03
[DENIS.PCITY.DAT]19JUN882.DAT;1               272  24-JUN-1988 13:55
[DENIS.PCITY.DAT]20J1505.DAT;1                134   3-NOV-1988 09:14
[DENIS.PCITY.DAT]20JUN881.DAT;1               373  30-JUN-1988 11:11
[DENIS.PCITY.DAT]21J1155.DAT;1                 94  24-JUN-1988 14:49
[DENIS.PCITY.DAT]21J1250.DAT;1                117  24-JUN-1988 14:53
[DENIS.PCITY.DAT]21J1353.DAT;1                 70  24-JUN-1988 14:58
[DENIS.PCITY.DAT]21J1441.DAT;1                 37  24-JUN-1988 15:01
[DENIS.PCITY.DAT]21J1519.DAT;1                 63  24-JUN-1988 15:02
[DENIS.PCITY.DAT]21J1602.DAT;1                 36  24-JUN-1988 15:05
[DENIS.PCITY.DAT]21J1630.DAT;1                101  24-JUN-1988 15:06
[DENIS.PCITY.DAT]21J1742.DAT;1                 38  24-JUN-1988 15:11
[DENIS.PCITY.DAT]21J1839.DAT;1                 88  24-JUN-1988 15:12
[DENIS.PCITY.DAT]21JUN881.DAT;1               169  24-JUN-1988 14:34
[DENIS.PCITY.DAT]21JUN882.DAT;1               116  24-JUN-1988 14:59
[DENIS.PCITY.DAT]21JUN883.DAT;1               206  24-JUN-1988 15:15
[DENIS.PCITY.DAT]21JUN884.DAT;1               211  18-JUL-1988 13:01
[DENIS.PCITY.DAT]21JUN885.DAT;1               175  18-JUL-1988 13:16
[DENIS.PCITY.DAT]CSRT.DAT;1                     1   3-NOV-1988 09:13
[DENIS.PCITY.DAT]FOR023.DAT;1                   2   4-NOV-1988 13:35
[DENIS.PCITY.DAT]FOR029.DAT;1                   1   4-NOV-1988 13:50
[DENIS.PCITY.DAT]FRAG.DAT;1                     6   7-NOV-1988 11:57
[DENIS.PCITY.DAT]FRAGMENT.DAT;3               139   3-NOV-1988 09:06
[DENIS.PCITY.DAT]FRAGMENT.DAT;2               134   3-NOV-1988 09:12
[DENIS.PCITY.DAT]IOP020.DAT;1                 127   4-NOV-1988 13:35
[DENIS.PCITY.DAT]TRANTEST.DAT;1                 6   7-NOV-1988 11:59
[DENIS.PCITY]DECLIST.TXT;2                      1  21-DEC-1988 10:34
[DENIS.PCITY]DECLIST.TXT;1                      1  21-DEC-1988 10:32
[DENIS.PCITY]FOR011.DAT;2                       6   1-DEC-1988 12:24
[DENIS.PCITY]FOR014.DAT;3                      17  13-DEC-1988 08:45
[DENIS.PCITY]FOR023.DAT;27                      2  22-DEC-1988 15:01
[DENIS.PCITY]FOR029.DAT;3                       1  21-DEC-1988 13:45
[DENIS.PCITY]FOR097.DAT;65                     77  21-DEC-1988 11:34
[DENIS.PCITY]FRAG.CNV;1                        10   7-NOV-1988 11:59
[DENIS.PCITY]GETMCA.COM;3                       1   1-DEC-1988 15:50
[DENIS.PCITY]IOP020.DAT;41                    130  21-DEC-1988 12:25
[DENIS.PCITY]LASER.TEK;20                    1291  21-DEC-1988 17:26
[DENIS.PCITY]LASER.TEK;19                    1348  21-DEC-1988 17:15
[DENIS.PCITY]LASER.TEK;18                     468  21-DEC-1988 15:10
[DENIS.PCITY]LN03PLUS.TXT;1                     1  20-DEC-1988 13:09
[DENIS.PCITY]LPLOT.COM;3                        1  21-DEC-1988 08:54
[DENIS.PCITY]LPLOT.COM;2                        1  21-DEC-1988 08:40
[DENIS.PCITY]LPLOT.COM;1                        1  21-DEC-1988 08:38
```

[DENIS.PCITY]M1.EXE;2	43	2-DEC-1988	12:30
[DENIS.PCITY]M1.FOR;3	12	2-DEC-1988	12:30
[DENIS.PCITY]M1.LIS;2	28	2-DEC-1988	12:30
[DENIS.PCITY]MAK.DAT;1	6	2-DEC-1988	14:44
[DENIS.PCITY]NICE1.OUT;17	7	27-DEC-1988	14:03
[DENIS.PCITY]PCITY.INFO;4	2	28-NOV-1988	11:27
[DENIS.PCITY]PCITY.INFO;3	1	28-NOV-1988	09:55
[DENIS.PCITY]PCITY.INFO;2	1	28-NOV-1988	09:49
[DENIS.PCITY]PCITY.INFO;1	1	28-NOV-1988	09:48
[DENIS.PCITY]PCITYMAP.COF;2	1	2-DEC-1988	12:30
[DENIS.PCITY]PCITYMAP.DAT;4	64	2-DEC-1988	09:17
[DENIS.PCITY]PCITYMAP.F10;4	73	13-DEC-1988	14:05
[DENIS.PCITY]PCITYMAP.MCA;4	64	2-DEC-1988	12:21
[DENIS.PCITY]PGMS.DIR;1	3	28-NOV-1988	09:37
[DENIS.PCITY.PGMS]ADDNUM.FOR;1	1	2-DEC-1988	08:31
[DENIS.PCITY.PGMS]CNVTLT.FOR;1	2	13-AUG-1986	14:41
[DENIS.PCITY.PGMS]COLLCT.FOR;1	6	5-FEB-1988	12:51
[DENIS.PCITY.PGMS]CONREC.FOR;1	84	1-DEC-1988	13:32
[DENIS.PCITY.PGMS]CONTOUR.FOR;161	23	27-DEC-1988	12:07
[DENIS.PCITY.PGMS]CONTOUROLD.FOR;1	18	8-DEC-1988	15:19
[DENIS.PCITY.PGMS]CONVRT.EXE;1	20	28-JUN-1988	16:01
[DENIS.PCITY.PGMS]CONVRT.FOR;1	21	5-FEB-1988	13:01
[DENIS.PCITY.PGMS]CONVRT88.EXE;1	22	12-JUL-1988	12:09
[DENIS.PCITY.PGMS]CONVRT88.FOR;2	37	27-DEC-1988	11:52
[DENIS.PCITY.PGMS]CONVRT88.FOR;1	37	12-JUL-1988	12:08
[DENIS.PCITY.PGMS]CONVRTEST.FOR;1	22	2-JUL-1986	11:28
[DENIS.PCITY.PGMS]CORR.SAS;1	2	27-DEC-1988	13:45
[DENIS.PCITY.PGMS]GRAPH.FOR;1	3	15-AUG-1986	16:33
[DENIS.PCITY.PGMS]JULIAN.FOR;1	1	22-JUN-1985	13:48
[DENIS.PCITY.PGMS]M1.FOR;1	13	27-DEC-1988	13:42
[DENIS.PCITY.PGMS]MERGETT.EXE;3	11	28-NOV-1988	11:15
[DENIS.PCITY.PGMS]MERGETT.FOR;5	9	27-DEC-1988	11:45
[DENIS.PCITY.PGMS]MERGETT.FOR;4	8	28-NOV-1988	11:14
[DENIS.PCITY.PGMS]NICE1.OUT;11	4	27-DEC-1988	14:46
[DENIS.PCITY.PGMS]OPTGRAPH.FOR;1	4	15-AUG-1986	16:35
[DENIS.PCITY.PGMS]PARSE.FOR;1	5	21-DEC-1984	08:43
[DENIS.PCITY.PGMS]PLOT.SAS;2	3	27-DEC-1988	14:45
[DENIS.PCITY.PGMS]PLOT.SAS;1	2	27-DEC-1988	13:50
[DENIS.PCITY.PGMS]PRETABLE.EXE;2	14	28-NOV-1988	11:02
[DENIS.PCITY.PGMS]PRETABLE.FOR;3	14	27-DEC-1988	12:01
[DENIS.PCITY.PGMS]PRETABLE.FOR;2	13	28-NOV-1988	11:01
[DENIS.PCITY.PGMS]PUTALL.SAS;1	2	27-DEC-1988	13:22
[DENIS.PCITY.PGMS]READ.SAS;1	3	27-DEC-1988	13:03
[DENIS.PCITY.PGMS]READ1.SAS;1	1	29-NOV-1988	15:23
[DENIS.PCITY.PGMS]READ350.FOR;1	6	27-DEC-1988	14:00
[DENIS.PCITY.PGMS]READJUN.EXE;1	10	9-JUL-1988	11:01
[DENIS.PCITY.PGMS]READJUN.FOR;2	8	27-DEC-1988	11:48
[DENIS.PCITY.PGMS]READJUN.FOR;1	8	9-JUL-1988	11:01
[DENIS.PCITY.PGMS]SET_42.FOR;1	2	21-DEC-1988	13:00
[DENIS.PCITY.PGMS]SUMMARY.SAS;1	1	29-NOV-1988	14:22
[DENIS.PCITY.PGMS]TESSPLOT.FOR;1	14	22-FEB-1988	16:18
[DENIS.PCITY.PGMS]TIMETST.EXE;1	8	29-JUN-1988	08:41
[DENIS.PCITY.PGMS]TIMETST.FOR;1	3	29-JUN-1988	09:30
[DENIS.PCITY.PGMS]TTPLOT.EXE;5	96	4-NOV-1988	11:43
[DENIS.PCITY.PGMS]TTPLOT.FOR;6	13	27-DEC-1988	14:40
[DENIS.PCITY.PGMS]TTPLOT.FOR;5	12	22-DEC-1988	14:05
[DENIS.PCITY.PGMS]TUPSPLOT.FOR;1	19	24-MAR-1988	16:36
[DENIS.PCITY]PLOT.LIS;3	21	22-DEC-1988	10:51
[DENIS.PCITY]PLOT.LOG;7	4	22-DEC-1988	10:50
[DENIS.PCITY]PLOTFLUOR.OUT;1	53	4-NOV-1988	11:03

```
[DENIS.PCITY]PRETABLE.OUT;1                       191   4-NOV-1988 11:04
[DENIS.PCITY]PROGRAMS.COM;1                         1  25-OCT-1988 13:42
[DENIS.PCITY]PUTALL.LOG;6                           3  12-DEC-1988 09:09
[DENIS.PCITY]READ.LOG;5                             7  29-NOV-1988 10:51
[DENIS.PCITY]READ1.LOG;3                            2  28-NOV-1988 13:30
[DENIS.PCITY]READ350.FOR;2                          5  19-DEC-1988 13:23
[DENIS.PCITY]RSAS.COM;1                             1  11-NOV-1988 11:49
[DENIS.PCITY]SAS.COM;2                              1  30-NOV-1988 16:06
[DENIS.PCITY]SAS.COM;1                              0  30-NOV-1988 16:05
[DENIS.PCITY]SET_42.FOR;1                           2  21-DEC-1988 12:59
[DENIS.PCITY]SET_42.LIS;1                           7  21-DEC-1988 13:00
[DENIS.PCITY]SUMMARY.LIS;1                          2  27-DEC-1988 13:46
[DENIS.PCITY]SUMMARY.LOG;2                          2  27-DEC-1988 13:45
[DENIS.PCITY]TEMP.LIS;1                             1   8-DEC-1988 13:45
[DENIS.PCITY]TEMP.MASK;4                            6   2-DEC-1988 17:58
[DENIS.PCITY]TEMP.TEMP;2                            6   2-DEC-1988 17:20
[DENIS.PCITY]TEMP.TEMP;1                            0   2-DEC-1988 17:14
[DENIS.PCITY]TTPLOT.EXE;20                        107  22-DEC-1988 14:05
[DENIS.PCITY]TTPLOT.FOR;19                         12  22-DEC-1988 13:26
[DENIS.PCITY]TTPLOT.INFO;1                          1  27-DEC-1988 14:14
[DENIS.PCITY]TTPLOT.LIS;16                         37  22-DEC-1988 14:05
[DENIS.PCITY]TTPLOT19.IOP;1                       409  21-DEC-1988 17:08
[DENIS.PCITY]TTPLOT19P.IOP;2                      392  22-DEC-1988 14:49
[DENIS.PCITY]TTPLOT20.IOP;8                       150  21-DEC-1988 15:09
[DENIS.PCITY]TTPLOT20P.IOP;2                      139  22-DEC-1988 14:17
[DENIS.PCITY]TTPLOT21.IOP;1                       403  21-DEC-1988 17:23
[DENIS.PCITY]TTPLOT21P.IOP;1                      384  22-DEC-1988 15:01

Total of 191 files, 33358 blocks
End of save set
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